MongoDB Documentation

Release 2.2.4

MongoDB Documentation Project

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Part I

Installing MongoDB

CHAPTER 1

Installation Guides

MongoDB runs on most platforms, and supports 32-bit and 64-bit architectures. 10gen, the MongoDB makers, provides both binaries and packages. Choose your platform below:

1.1 Install MongoDB on Red Hat Enterprise, CentOS, or Fedora Linux

1.1.1 Synopsis

This tutorial outlines the basic installation process for deploying *MongoDB* on Red Hat Enterprise Linux, CentOS Linux, Fedora Linux and related systems. This procedure uses `.rpm` packages as the basis of the installation. 10gen publishes packages of the MongoDB releases as `.rpm` packages for easy installation and management for users of CentOS, Fedora and Red Hat Enterprise Linux systems. While some of these distributions include their own MongoDB packages, the 10gen packages are generally more up to date.

This tutorial includes: an overview of the available packages, instructions for configuring the package manager, the process install packages from the 10gen repository, and preliminary MongoDB configuration and operation.

See Also:

Additional installation tutorials:

- `http://docs.mongodb.org/v2.2/tutorial/install-mongodb-on-debian-or-ubuntu-linux`
- *Install MongoDB on Debian* (page 9)
- *Install MongoDB on Ubuntu* (page 6)
- *Install MongoDB on Linux* (page 12)
- *Install MongoDB on OS X* (page 13)
- *Install MongoDB on Windows* (page 16)

1.1.2 Package Options

The 10gen repository contains two packages:

- `mongo-10gen-server`

This package contains the mongod (page 897) and mongos (page 905) daemons from the latest **stable** release and associated configuration and init scripts. Additionally, you can use this package to *install daemons from a previous release* (page 4) of MongoDB.

- mongo-10gen

  This package contains all MongoDB tools from the latest **stable** release. Additionally, you can use this package to *install tools from a previous release* (page 4) of MongoDB. Install this package on all production MongoDB hosts and optionally on other systems from which you may need to administer MongoDB systems.

1.1.3 Installing MongoDB

Configure Package Management System (YUM)

Create a http://docs.mongodb.org/v2.2/etc/yum.repos.d/10gen.repo file to hold information about your repository. If you are running a 64-bit system (recommended,) place the following configuration in http://docs.mongodb.org/v2.2/etc/yum.repos.d/10gen.repo file:

```
[10gen]
name=10gen Repository
baseurl=http://downloads-distro.mongodb.org/repo/redhat/os/x86_64
gpgcheck=0
enabled=1
```

If you are running a 32-bit system, which isn't recommended for production deployments, place the following configuration in http://docs.mongodb.org/v2.2/etc/yum.repos.d/10gen.repo file:

```
[10gen]
name=10gen Repository
baseurl=http://downloads-distro.mongodb.org/repo/redhat/os/i686
gpgcheck=0
enabled=1
```

Installing Packages

Issue the following command (as root or with sudo) to install the latest stable version of MongoDB and the associated tools:

```
yum install mongo-10gen mongo-10gen-server
```

When this command completes, you have successfully installed MongoDB!

Manage Installed Versions

You can use the mongo-10gen and mongo-10gen-server packages to install previous releases of MongoDB. To install a specific release, append the version number, as in the following example:

```
yum install mongo-10gen-2.2.3 mongo-10gen-server-2.2.3
```

This installs the mongo-10gen and mongo-10gen-server packages with the 2.2.3 release. You can specify any available version of MongoDB; however yum **will** upgrade the mongo-10gen and mongo-10gen-server packages when a newer version becomes available. Use the following *pinning* procedure to prevent unintended upgrades.

To pin a package, add the following line to your http://docs.mongodb.org/v2.2/etc/yum.conf file:

```
exclude=mongo-10gen,mongo-10gen-server
```

1.1.4 Configure MongoDB

These packages configure MongoDB using the `http://docs.mongodb.org/v2.2/etc/mongod.conf` file in conjunction with the *control script*. You can find the init script at `http://docs.mongodb.org/v2.2/etc/rc.d/init.d/mongod`.

This MongoDB instance will store its data files in the `http://docs.mongodb.org/v2.2/var/lib/mongo` and its log files in `http://docs.mongodb.org/v2.2/var/log/mongo`, and run using the `mongod` user account.

Note: If you change the user that runs the MongoDB process, you will need to modify the access control rights to the `http://docs.mongodb.org/v2.2/var/lib/mongo` and `http://docs.mongodb.org/v2.2/var/log/mongo` directories.

1.1.5 Control MongoDB

Warning: With the introduction of `systemd` in Fedora 15, the control scripts included in the packages available in the 10gen repository are not compatible with Fedora systems. A correction is forthcoming, see SERVER-7285 for more information, and in the mean time use your own control scripts *or* install using the procedure outlined in *Install MongoDB on Linux* (page 12).

Start MongoDB

Start the `mongod` (page 897) process by issuing the following command (as root, or with `sudo`):

```
service mongod start
```

You can verify that the `mongod` (page 897) process has started successfully by checking the contents of the log file at `http://docs.mongodb.org/v2.2/var/log/mongo/mongod.log`.

You may optionally, ensure that MongoDB will start following a system reboot, by issuing the following command (with root privileges:)

```
chkconfig mongod on
```

Stop MongoDB

Stop the `mongod` (page 897) process by issuing the following command (as root, or with `sudo`):

```
service mongod stop
```

Restart MongoDB

You can restart the `mongod` (page 897) process by issuing the following command (as root, or with `sudo`):

```
service mongod restart
```

Follow the state of this process by watching the output in the `http://docs.mongodb.org/v2.2/var/log/mongo/mongod.l` file to watch for errors or important messages from the server.

Control `mongos`

As of the current release, there are no *control scripts* for `mongos` (page 905). `mongos` (page 905) is only used in sharding deployments and typically do not run on the same systems where `mongod` (page 897) runs. You can use the `mongodb` script referenced above to derive your own `mongos` (page 905) control script.

SELinux Considerations

You must SELinux to allow MongoDB to start on Fedora systems. Administrators have two options:

- enable access to the relevant ports (e.g. 27017) for SELinux. See *Interfaces and Port Numbers* (page 88) for more information on MongoDB's default ports.
- disable SELinux entirely. This requires a system reboot and may have larger implications for your deployment.

1.1.6 Using MongoDB

Among the tools included in the `mongo-10gen` package, is the `mongo` (page 908) shell. You can connect to your MongoDB instance by issuing the following command at the system prompt:

```
mongo
```

This will connect to the database running on the localhost interface by default. At the `mongo` (page 908) prompt, issue the following two commands to insert a record in the "test" *collection* of the (default) "test" database and then retrieve that document.

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"`mongo` (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)"

1.2 Install MongoDB on Ubuntu

1.2.1 Synopsis

This tutorial outlines the basic installation process for installing *MongoDB* on Ubuntu Linux systems. This tutorial uses `.deb` packages as the basis of the installation. 10gen publishes packages of the MongoDB releases as `.deb` packages for easy installation and management for users of Ubuntu systems. Although Ubuntu does include MongoDB packages, the 10gen packages are generally more up to date.

This tutorial includes: an overview of the available packages, instructions for configuring the package manager, the process for installing packages from the 10gen repository, and preliminary MongoDB configuration and operation.

Note: If you use an older Ubuntu that does **not** use Upstart, (i.e. any version before 9.10 "Karmic") please follow the instructions on the *Install MongoDB on Debian* (page 9) tutorial.

See Also:

Additional installation tutorials:

- *Install MongoDB on Red Hat Enterprise, CentOS, or Fedora Linux* (page 3)
- *Install MongoDB on Debian* (page 9)
- *Install MongoDB on Linux* (page 12)
- *Install MongoDB on OS X* (page 13)
- *Install MongoDB on Windows* (page 16)

1.2.2 Package Options

The 10gen repository provides the `mongodb-10gen` package, which contains the latest **stable** release. Additionally you can *install previous releases* (page 7) of MongoDB.

You cannot install this package concurrently with the `mongodb`, `mongodb-server`, or `mongodb-clients` packages provided by Ubuntu.

1.2.3 Installing MongoDB

Configure Package Management System (APT)

The Ubuntu package management tool (i.e. `dpkg` and `apt`) ensure package consistency and authenticity by requiring that distributors sign packages with GPG keys. Issue the following command to import the 10gen public GPG Key:

```
sudo apt-key adv --keyserver keyserver.ubuntu.com --recv 7F0CEB10
```

Create a `http://docs.mongodb.org/v2.2/etc/apt/sources.list.d/10gen.list` file and include the following line for the 10gen repository.

```
deb http://downloads-distro.mongodb.org/repo/ubuntu-upstart dist 10gen
```

Now issue the following command to reload your repository:

```
sudo apt-get update
```

Manage Installed Versions

You can use the `mongodb-10gen` package to install previous versions of MongoDB. To install a specific release, append the version number to the package name, as in the following example:

```
apt-get install mongodb-10gen=2.2.3
```

This will install the `2.2.3` release of MongoDB. You can specify any available version of MongoDB; however `apt-get` **will** upgrade the `mongodb-10gen` package when a newer version becomes available. Use the following *pinning* procedure to prevent unintended upgrades.

To pin a package, issue the following command at the system prompt to *pin* the version of MongoDB at the currently installed version:

```
echo "mongodb-10gen hold" | dpkg --set-selections
```

Install Packages

Issue the following command to install the latest stable version of MongoDB:

```
sudo apt-get install mongodb-10gen
```

When this command completes, you have successfully installed MongoDB! Continue for configuration and start-up suggestions.

1.2.4 Configure MongoDB

These packages configure MongoDB using the `http://docs.mongodb.org/v2.2/etc/mongodb.conf` file in conjunction with the *control script*. You will find the control script is at `http://docs.mongodb.org/v2.2/etc/init.d/mongodb`.

This MongoDB instance will store its data files in the `http://docs.mongodb.org/v2.2/var/lib/mongodb` and its log files in `http://docs.mongodb.org/v2.2/var/log/mongodb`, and run using the `mongodb` user account.

Note: If you change the user that runs the MongoDB process, you will need to modify the access control rights to the `http://docs.mongodb.org/v2.2/var/lib/mongodb` and `http://docs.mongodb.org/v2.2/var/log/mongodb` directories.

1.2.5 Controlling MongoDB

Starting MongoDB

You can start the `mongod` (page 897) process by issuing the following command:

```
sudo service mongodb start
```

You can verify that `mongod` (page 897) has started successfully by checking the contents of the log file at `http://docs.mongodb.org/v2.2/var/log/mongodb/mongodb.log`.

Stopping MongoDB

As needed, you may stop the `mongod` (page 897) process by issuing the following command:

```
sudo service mongodb stop
```

Restarting MongoDB

You may restart the `mongod` (page 897) process by issuing the following command:

```
sudo service mongodb restart
```

Controlling `mongos`

As of the current release, there are no *control scripts* for `mongos` (page 905). `mongos` (page 905) is only used in sharding deployments and typically do not run on the same systems where `mongod` (page 897) runs. You can use the `mongodb` script referenced above to derive your own `mongos` (page 905) control script.

1.2.6 Using MongoDB

Among the tools included with the MongoDB package, is the `mongo` (page 908) shell. You can connect to your MongoDB instance by issuing the following command at the system prompt:

```
mongo
```

This will connect to the database running on the localhost interface by default. At the `mongo` (page 908) prompt, issue the following two commands to insert a record in the "test" *collection* of the (default) "test" database.

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"`mongo` (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)"

1.3 Install MongoDB on Debian

1.3.1 Synopsis

This tutorial outlines the basic installation process for installing *MongoDB* on Debian systems. This tutorial uses `.deb` packages as the basis of the installation. 10gen publishes packages of the MongoDB releases as `.deb` packages for easy installation and management for users of Debian systems. While some of these distributions include their own MongoDB packages, the 10gen packages are generally more up to date.

This tutorial includes: an overview of the available packages, instructions for configuring the package manager, the process for installing packages from the 10gen repository, and preliminary MongoDB configuration and operation.

Note: This tutorial applies to both Debian systems and versions of Ubuntu Linux prior to 9.10 "Karmic" which do not use Upstart. Other Ubuntu users will want to follow the *Install MongoDB on Ubuntu* (page 6) tutorial.

See Also:

Additional installation tutorials:

- *Install MongoDB on Red Hat Enterprise, CentOS, or Fedora Linux* (page 3)
- *Install MongoDB on Ubuntu* (page 6)
- *Install MongoDB on Linux* (page 12)
- *Install MongoDB on OS X* (page 13)
- *Install MongoDB on Windows* (page 16)

1.3.2 Package Options

The 10gen repository provides the `mongodb-10gen` package, which contains the latest **stable** release. Additionally you can *install previous releases* (page 10) of MongoDB.

You cannot install this package concurrently with the `mongodb`, `mongodb-server`, or `mongodb-clients` packages that your release of Debian may include.

1.3.3 Installing MongoDB

Configure Package Management System (APT)

The Debian package management tool (i.e. `dpkg` and `apt`) ensure package consistency and authenticity by requiring that distributors sign packages with GPG keys. Issue the following command to import the 10gen public GPG Key:

```
sudo apt-key adv --keyserver keyserver.ubuntu.com --recv 7F0CEB10
```

Create a the `http://docs.mongodb.org/v2.2/etc/apt/sources.list.d/10gen.list` file and include the following line for the 10gen repository.

```
deb http://downloads-distro.mongodb.org/repo/debian-sysvinit dist 10gen
```

Now issue the following command to reload your repository:

```
sudo apt-get update
```

Install Packages

Issue the following command to install the latest stable version of MongoDB:

```
sudo apt-get install mongodb-10gen
```

When this command completes, you have successfully installed MongoDB!

Manage Installed Versions

You can use the `mongodb-10gen` package to install previous versions of MongoDB. To install a specific release, append the version number to the package name, as in the following example:

```
apt-get install mongodb-10gen=2.2.3
```

This will install the `2.2.3` release of MongoDB. You can specify any available version of MongoDB; however `apt-get` **will** upgrade the `mongodb-10gen` package when a newer version becomes available. Use the following *pinning* procedure to prevent unintended upgrades.

To pin a package, issue the following command at the system prompt to *pin* the version of MongoDB at the currently installed version:

```
echo "mongodb-10gen hold" | dpkg --set-selections
```

1.3.4 Configure MongoDB

These packages configure MongoDB using the `http://docs.mongodb.org/v2.2/etc/mongodb.conf` file in conjunction with the *control script*. You can find the control script at `http://docs.mongodb.org/v2.2/etc/init.d/mongodb`.

This MongoDB instance will store its data files in the `http://docs.mongodb.org/v2.2/var/lib/mongodb` and its log files in `http://docs.mongodb.org/v2.2/var/log/mongodb`, and run using the `mongodb` user account.

Note: If you change the user that runs the MongoDB process, you will need to modify the access control rights to the `http://docs.mongodb.org/v2.2/var/lib/mongodb` and `http://docs.mongodb.org/v2.2/var/log/mongodb` directories.

1.3.5 Controlling MongoDB

Starting MongoDB

Issue the following command to start mongod (page 897):

```
sudo /etc/init.d/mongodb start
```

You can verify that mongod (page 897) has started successfully by checking the contents of the log file at http://docs.mongodb.org/v2.2/var/log/mongodb/mongodb.log.

Stopping MongoDB

Issue the following command to stop mongod (page 897):

```
sudo /etc/init.d/mongodb stop
```

Restarting MongoDB

Issue the following command to restart mongod (page 897):

```
sudo /etc/init.d/mongodb restart
```

Controlling mongos

As of the current release, there are no *control scripts* for mongos (page 905). mongos (page 905) is only used in sharding deployments and typically do not run on the same systems where mongod (page 897) runs. You can use the mongodb script referenced above to derive your own mongos (page 905) control script.

1.3.6 Using MongoDB

Among the tools included with the MongoDB package, is the mongo (page 908) shell. You can connect to your MongoDB instance by issuing the following command at the system prompt:

```
mongo
```

This will connect to the database running on the localhost interface by default. At the mongo (page 908) prompt, issue the following two commands to insert a record in the "test" *collection* of the (default) "test" database.

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"mongo (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)"

1.4 Install MongoDB on Linux

1.4.1 Synopsis

10gen provides compiled versions of *MongoDB* for use on Linux that provides a simple option for users who cannot use packages. This tutorial outlines the basic installation of MongoDB using these compiled versions and an initial usage guide.

See Also:

Additional installation tutorials:

- *Install MongoDB on Red Hat Enterprise, CentOS, or Fedora Linux* (page 3)
- *Install MongoDB on Ubuntu* (page 6)
- *Install MongoDB on Debian* (page 9)
- *Install MongoDB on OS X* (page 13)
- *Install MongoDB on Windows* (page 16)

1.4.2 Download MongoDB

Note: You should place the MongoDB binaries in a central location on the file system that is easy to access and control. Consider `http://docs.mongodb.org/v2.2/opt` or `http://docs.mongodb.org/v2.2/usr/local/bin`.

In a terminal session, begin by downloading the latest release. In most cases you will want to download the 64-bit version of MongoDB.

```
curl http://downloads.mongodb.org/linux/mongodb-linux-x86_64-2.2.4.tgz > mongodb.tgz
```

If you need to run the 32-bit version, use the following command.

```
curl http://downloads.mongodb.org/linux/mongodb-linux-i686-2.2.4.tgz > mongodb.tgz
```

Once you've downloaded the release, issue the following command to extract the files from the archive:

```
tar -zxvf mongodb.tgz
```

Optional

You may use the following command to copy the extracted folder into a more generic location.

```
cp -R -n  mongodb-linux-????-??-??/ mongodb
```

You can find the `mongod` (page 897) binary, and the binaries all of the associated MongoDB utilities, in the `bin/` directory within the extracted directory.

Using MongoDB

Before you start `mongod` (page 897) for the first time, you will need to create the data directory. By default, `mongod` (page 897) writes data to the `http://docs.mongodb.org/v2.2/data/db/` directory. To create this directory, use the following command:

```
mkdir -p /data/db
```

Note: Ensure that the system account that will run the mongod (page 897) process has read and write permissions to this directory. If mongod (page 897) runs under the mongo user account, issue the following command to change the owner of this folder:

```
chown mongo /data/db
```

If you use an alternate location for your data directory, ensure that this user can write to your chosen data path.

You can specify, and create, an alternate path using the *--dbpath* (page 899) option to mongod (page 897) and the above command.

The 10gen builds of MongoDB contain no *control scripts* or method to control the mongod (page 897) process. You may wish to create control scripts, modify your path, and/or create symbolic links to the MongoDB programs in your http://docs.mongodb.org/v2.2/usr/local/bin or http://docs.mongodb.org/v2.2/usr/bin directory for easier use.

For testing purposes, you can start a mongod (page 897) directly in the terminal without creating a control script:

```
mongod --config /etc/mongod.conf
```

Note: The above command assumes that the mongod (page 897) binary is accessible via your system's search path, and that you have created a default configuration file located at http://docs.mongodb.org/v2.2/etc/mongod.conf.

Among the tools included with this MongoDB distribution, is the mongo (page 908) shell. You can use this shell to connect to your MongoDB instance by issuing the following command at the system prompt:

```
./bin/mongo
```

Note: The ./bin/mongo command assumes that the mongo (page 908) binary is in the bin/ sub-directory of the current directory. This is the directory into which you extracted the .tgz file.

This will connect to the database running on the localhost interface by default. At the mongo (page 908) prompt, issue the following two commands to insert a record in the "test" *collection* of the (default) "test" database and then retrieve that record:

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"mongo (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)"

1.5 Install MongoDB on OS X

1.5.1 Synopsis

This tutorial outlines the basic installation process for deploying *MongoDB* on Macintosh OS X systems. This tutorial provides two main methods of installing the MongoDB server (i.e. "mongod (page 897)") and associated tools: first using the community package management tools, and second using builds of MongoDB provided by 10gen.

See Also:

Additional installation tutorials:

- *Install MongoDB on Red Hat Enterprise, CentOS, or Fedora Linux* (page 3)
- *Install MongoDB on Ubuntu* (page 6)
- *Install MongoDB on Debian* (page 9)
- *Install MongoDB on Linux* (page 12)
- *Install MongoDB on Windows* (page 16)

1.5.2 Installing with Package Management

Both community package management tools: Homebrew and MacPorts require some initial setup and configuration. This configuration is beyond the scope of this document. You only need to use one of these tools.

If you want to use package management, and do not already have a system installed, Homebrew is typically easier and simpler to use.

Homebrew

Homebrew installs binary packages based on published "formula." Issue the following command at the system shell to update the `brew` package manager:

```
brew update
```

Use the following command to install the MongoDB package into your Homebrew system.

```
brew install mongodb
```

Later, if you need to upgrade MongoDB, you can issue the following sequence of commands to update the MongoDB installation on your system:

```
brew update
brew upgrade mongodb
```

MacPorts

MacPorts distributes build scripts that allow you to easily build packages and their dependencies on your own system. The compilation process can take significant period of time depending on your system's capabilities and existing dependencies. Issue the following command in the system shell:

```
port install mongodb
```

Using MongoDB from Homebrew and MacPorts

The packages installed with Homebrew and MacPorts contain no *control scripts* or interaction with the system's process manager.

If you have configured Homebrew and MacPorts correctly, including setting your `PATH`, the MongoDB applications and utilities will be accessible from the system shell. Start the `mongod` (page 897) process in a terminal (for testing or development) or using a process management tool.

```
mongod
```

Then open the mongo (page 908) shell by issuing the following command at the system prompt:

```
mongo
```

This will connect to the database running on the localhost interface by default. At the mongo (page 908) prompt, issue the following two commands to insert a record in the "test" *collection* of the (default) "test" database and then retrieve that record.

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"mongo (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)"

1.5.3 Installing from 10gen Builds

10gen provides compiled binaries of all MongoDB software compiled for OS X, which may provide a more straightforward installation process.

Download MongoDB

In a terminal session, begin by downloading the latest release. Use the following command at the system prompt:

```
curl http://downloads.mongodb.org/osx/mongodb-osx-x86_64-2.2.4.tgz > mongodb.tgz
```

Note: The mongod (page 897) process will not run on older Macintosh computers with PowerPC (i.e. non-Intel) processors.

Once you've downloaded the release, issue the following command to extract the files from the archive:

```
tar -zxvf mongodb.tgz
```

Optional

You may use the following command to move the extracted folder into a more generic location.

```
mv -n mongodb-osx-[platform]-[version]/ /path/to/new/location/
```

Replace `[platform]` with `i386` or `x86_64` depending on your system and the version you downloaded, and `[version]` with 2.2 or the version of MongoDB that you are installing.

You can find the mongod (page 897) binary, and the binaries all of the associated MongoDB utilities, in the `bin/` directory within the archive.

Using MongoDB from 10gen Builds

Before you start mongod (page 897) for the first time, you will need to create the data directory. By default, mongod (page 897) writes data to the `http://docs.mongodb.org/v2.2/data/db/` directory. To create this directory, and set the appropriate permissions use the following commands:

```
sudo mkdir -p /data/db
sudo chown `id -u` /data/db
```

You can specify an alternate path for data files using the *--dbpath* (page 899) option to mongod (page 897).

The 10gen builds of MongoDB contain no *control scripts* or method to control the mongod (page 897) process. You may wish to create control scripts, modify your path, and/or create symbolic links to the MongoDB programs in your http://docs.mongodb.org/v2.2/usr/local/bin directory for easier use.

For testing purposes, you can start a mongod (page 897) directly in the terminal without creating a control script:

```
mongod --config /etc/mongod.conf
```

Note: This command assumes that the mongod (page 897) binary is accessible via your system's search path, and that you have created a default configuration file located at http://docs.mongodb.org/v2.2/etc/mongod.conf.

Among the tools included with this MongoDB distribution, is the mongo (page 908) shell. You can use this shell to connect to your MongoDB instance by issuing the following command at the system prompt from inside of the directory where you extracted mongo (page 908):

```
./bin/mongo
```

Note: The ./bin/mongo command assumes that the mongo (page 908) binary is in the bin/ sub-directory of the current directory. This is the directory into which you extracted the .tgz file.

This will connect to the database running on the localhost interface by default. At the mongo (page 908) prompt, issue the following two commands to insert a record in the "test" *collection* of the (default) "test" database and then retrieve that record:

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"mongo (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)"

1.6 Install MongoDB on Windows

1.6.1 Synopsis

This tutorial provides a method for installing and running the MongoDB server (i.e. "mongod.exe (page 912)") on the Microsoft Windows platform through the *Command Prompt* and outlines the process for setting up MongoDB as a *Windows Service*.

Operating MongoDB with Windows is similar to MongoDB on other platforms. Most components share the same operational patterns.

1.6.2 Procedure

Download MongoDB for Windows

Download the latest production release of MongoDB from the MongoDB downloads page.

There are three builds of MongoDB for Windows:

- MongoDB for Windows Server 2008 R2 edition (i.e. 2008R2) only runs on Windows Server 2008 R2, Windows 7 64-bit, and newer versions of Windows. This build takes advantage of recent enhancements to the Windows Platform and cannot operate on older versions of Windows.
- MongoDB for Windows 64-bit runs on any 64-bit version of Windows newer than Windows XP, including Windows Server 2008 R2 and Windows 7 64-bit.
- MongoDB for Windows 32-bit runs on any 32-bit version of Windows newer than Windows XP. 32-bit versions of MongoDB are only intended for older systems and for use in testing and development systems.

Changed in version 2.2: MongoDB does not support Windows XP. Please use a more recent version of Windows to use more recent releases of MongoDB.

Note: Always download the correct version of MongoDB for your Windows system. The 64-bit versions of MongoDB will not work with 32-bit Windows.

32-bit versions of MongoDB are suitable only for testing and evaluation purposes and only support databases smaller than 2GB.

You can find the architecture of your version of Windows platform using the following command in the *Command Prompt*:

```
wmic os get osarchitecture
```

In Windows Explorer, find the MongoDB download file, typically in the default Downloads directory. Extract the archive to `C:\` by right clicking on the archive and selecting *Extract All* and browsing to `C:\`.

Note: The folder name will be either:

```
C:\mongodb-win32-i386-[version]
```

Or:

```
C:\mongodb-win32-x86_64-[version]
```

In both examples, replace `[version]` with the version of MongoDB downloaded.

Set up the Environment

Start the *Command Prompt* by selecting the *Start Menu*, then *All Programs*, then *Accessories*, then right click *Command Prompt*, and select *Run as Administrator* from the popup menu. In the *Command Prompt*, issue the following commands:

```
cd \
move C:\mongodb-win32-* C:\mongodb
```

Note: MongoDB is self-contained and does not have any other system dependencies. You can run MongoDB from any folder you choose. You may install MongoDB in any directory (e.g. `D:\test\mongodb`)

MongoDB requires a *data folder* to store its files. The default location for the MongoDB data directory is `C:\data\db`. Create this folder using the *Command Prompt*. Issue the following command sequence:

```
md data
md data\db
```

Note: You may specify an alternate path for `\data\db` with the dbpath (page 947) setting for mongod.exe (page 912), as in the following example:

```
C:\mongodb\bin\mongod.exe --dbpath d:\test\mongodb\data
```

If your path includes spaces, enclose the entire path in double quotations, for example:

```
C:\mongodb\bin\mongod.exe --dbpath "d:\test\mongo db data"
```

Start MongoDB

To start MongoDB, execute from the *Command Prompt*:

```
C:\mongodb\bin\mongod.exe
```

This will start the main MongoDB database process. The `waiting for connections` message in the console output indicates that the mongod.exe process is running successfully.

Note: Depending on the security level of your system, Windows will issue a *Security Alert* dialog box about blocking "some features" of `C:\\mongodb\bin\mongod.exe` from communicating on networks. All users should select `Private Networks, such as my home or work network` and click `Allow access`. For additional information on security and MongoDB, please read the *Security Practices and Management* (page 87) page.

Warning: Do not allow mongod.exe (page 912) to be accessible to public networks without running in "Secure Mode" (i.e. `auth` (page 947).) MongoDB is designed to be run in "trusted environments" and the database does not enable authentication or "Secure Mode" by default.

Connect to MongoDB using the mongo.exe (page 908) shell. Open another *Command Prompt* and issue the following command:

```
C:\mongodb\bin\mongo.exe
```

Note: Executing the command `start C:\mongodb\bin\mongo.exe` will automatically start the `mongo.exe` shell in a separate *Command Prompt* window.

The mongo.exe (page 908) shell will connect to mongod.exe (page 912) running on the localhost interface and port `27017` by default. At the mongo.exe (page 908) prompt, issue the following two commands to insert a record in the `test` *collection* of the default `test` database and then retrieve that record:

```
> db.test.save( { a: 1 } )
> db.test.find()
```

See Also:

"mongo (page 908)" and "*mongo Shell JavaScript Quick Reference* (page 889)." If you want to develop applications using .NET, see the documentation of C# and MongoDB for more information.

1.6.3 MongoDB as a Windows Service

New in version 2.0. Setup MongoDB as a *Windows Service*, so that the database will start automatically following each reboot cycle.

Note: `mongod.exe` (page 912) added support for running as a Windows service in version 2.0, and `mongos.exe` (page 913) added support for running as a Windows Service in version 2.1.1.

Configure the System

You should specify two options when running MongoDB as a Windows Service: a path for the log output (i.e. `logpath` (page 946)) and a *configuration file* (page 944).

1. Create a specific directory for MongoDB log files:

   ```
   md C:\mongodb\log
   ```

2. Create a configuration file for the `logpath` (page 946) option for MongoDB in the *Command Prompt* by issuing this command:

   ```
   echo logpath=C:\mongodb\log\mongo.log > C:\mongodb\mongod.cfg
   ```

While these optional steps are optional, creating a specific location for log files and using the configuration file are good practice.

Note: Consider setting the `logappend` (page 946) option. If you do not, `mongod.exe` (page 912) will delete the contents of the existing log file when starting. Changed in version 2.2: The default `logpath` (page 946) and `logappend` (page 946) behavior changed in the 2.2 release.

Install and Run the MongoDB Service

Run all of the following commands in *Command Prompt* with "Administrative Privileges:"

1. To install the MongoDB service:

   ```
   C:\mongodb\bin\mongod.exe --config C:\mongodb\mongod.cfg --install
   ```

   Modify the path to the `mongod.cfg` file as needed. For the `--install` (page 912) option to succeed, you *must* specify a `logpath` (page 946) setting or the `--logpath` (page 898) run-time option.

2. To run the MongoDB service:

   ```
   net start MongoDB
   ```

Note: If you wish to use an alternate path for your `dbpath` (page 947) specify it in the config file (e.g. `C:\mongodb\mongod.cfg`) on that you specified in the `--install` (page 912) operation. You may also specify `--dbpath` (page 899) on the command line; however, always prefer the configuration file.

If the `dbpath` (page 947) directory does not exist, `mongod.exe` (page 912) will not be able to start. The default value for `dbpath` (page 947) is `\data\db`.

Stop or Remove the MongoDB Service

- To stop the MongoDB service:

  ```
  net stop MongoDB
  ```

- To remove the MongoDB service:

  ```
  C:\mongodb\bin\mongod.exe --remove
  ```

After you have installed MongoDB, consider the following documents as you begin to learn about MongoDB:

1.7 Getting Started with MongoDB Development

This tutorial provides an introduction to basic database operations using the mongo (page 908) shell. mongo (page 908) is a part of the standard MongoDB distribution and provides a full JavaScript environment with a complete access to the JavaScript language and all standard functions as well as a full database interface for MongoDB. See the mongo JavaScript API documentation and the mongo (page 908) shell *JavaScript Method Reference* (page 889).

The tutorial assumes that you're running MongoDB on a Linux or OS X operating system and that you have a running database server; MongoDB does support Windows and provides a Windows distribution with identical operation. For instructions on installing MongoDB and starting the database server see the appropriate *installation* (page 3) document.

This tutorial addresses the following aspects of MongoDB use:

- Connect to a Database (page 20)
  - Connect to a mongod (page 897) (page 20)
  - Select a Database (page 21)
  - Display mongo Help (page 21)
- Create a Collection and Insert Documents (page 21)
  - Insert Individual Documents (page 21)
  - Insert Multiple Documents Using a For Loop (page 22)
- Working with the Cursor (page 23)
  - Iterate over the Cursor with a Loop (page 23)
  - Use Array Operations with the Cursor (page 24)
  - Query for Specific Documents (page 24)
  - Return a Single Document from a Collection (page 26)
  - Limit the Number of Documents in the Result Set (page 26)
- Next Steps with MongoDB (page 26)

1.7.1 Connect to a Database

In this section you connect to the database server, which runs as mongod (page 897), and begin using the mongo (page 908) shell to select a logical database within the database instance and access the help text in the mongo (page 908) shell.

Connect to a mongod

From a system prompt, start mongo (page 908) by issuing the mongo (page 908) command, as follows:

```
mongo
```

By default, mongo (page 908) looks for a database server listening on port 27017 on the localhost interface. To connect to a server on a different port or interface, use the --port (page 908) and --host (page 908) options.

Select a Database

After starting the mongo (page 908) shell your session will use the test database for context, by default. At any time issue the following operation at the mongo (page 908) to report the current database:

```
db
```

db returns the name of the current database.

1. From the mongo (page 908) shell, display the list of databases with the following operation:

   ```
   show dbs
   ```

2. Switch to a new database named mydb with the following operation:

   ```
   use mydb
   ```

3. Confirm that your session has the mydb database as context, using the db operation, which returns the name of the current database as follows:

   ```
   db
   ```

At this point, if you issue the show dbs operation again, it will not include mydb, because MongoDB will not create a database until you insert data into that database. The *Create a Collection and Insert Documents* (page 21) section describes the process for inserting data.

Display mongo Help

At any point you can access help for the mongo (page 908) shell using the following operation:

```
help
```

Furthermore, you can append the .help() method to some JavaScript methods, any cursor object, as well as the db and db.collection objects to return additional help information.

1.7.2 Create a Collection and Insert Documents

In this section, you insert documents into a new *collection* named things within the new *database* named mydb.

MongoDB will create collections and databases implicitly upon their first use: you do not need to create the database or collection before inserting data. Furthermore, because MongoDB uses *dynamic schemas* (page 636), you do not need to specify the structure of your documents before inserting them into the collection.

Insert Individual Documents

1. From the mongo (page 908) shell, confirm that the current context is the mydb database with the following operation:

   ```
   db
   ```

2. If mongo (page 908) does not return mydb for the previous operation, set the context to the mydb database with the following operation:

   ```
   use mydb
   ```

3. Create two documents, named j and k, with the following sequence of JavaScript operations:

   ```
   j = { name : "mongo" }
   k = { x : 3 }
   ```

4. Insert the j and k documents into the collection things with the following sequence of operations:

   ```
   db.things.insert( j )
   db.things.insert( k )
   ```

   When you insert the first document, the mongod (page 897) will create both the mydb database and the things collection.

5. Confirm that the collection named things exists using the following operation:

   ```
   show collections
   ```

   The mongo (page 908) shell will return the list of the collections in the current (i.e. mydb) database. At this point, the only collection is things. All mongod (page 897) databases also have a system.indexes (page 1020) collection.

6. Confirm that the documents exist in the collection things by issuing query on the things collection. Using the find() (page 820) method in an operation that resembles the following:

   ```
   db.things.find()
   ```

   This operation returns the following results. The *ObjectId* (page 142) values will be unique:

   ```
   { "_id" : ObjectId("4c2209f9f3924d31102bd84a"), "name" : "mongo" }
   { "_id" : ObjectId("4c2209fef3924d31102bd84b"), "x" : 3 }
   ```

   All MongoDB documents must have an _id field with a unique value. These operations do not explicitly specify a value for the _id field, so mongo (page 908) creates a unique *ObjectId* (page 142) value for the field before inserting it into the collection.

Insert Multiple Documents Using a For Loop

1. From the mongo (page 908) shell, add more documents to the things collection using the following for loop:

   ```
   for (var i = 1; i <= 20; i++) db.things.insert( { x : 4 , j : i } )
   ```

2. Query the collection by issuing the following command:

   ```
   db.things.find()
   ```

   The mongo (page 908) shell displays the first 20 documents in the collection. Your *ObjectId* (page 142) values will be different:

   ```
   { "_id" : ObjectId("4c2209f9f3924d31102bd84a"), "name" : "mongo" }
   { "_id" : ObjectId("4c2209fef3924d31102bd84b"), "x" : 3 }
   { "_id" : ObjectId("4c220a42f3924d31102bd856"), "x" : 4, "j" : 1 }
   { "_id" : ObjectId("4c220a42f3924d31102bd857"), "x" : 4, "j" : 2 }
   { "_id" : ObjectId("4c220a42f3924d31102bd858"), "x" : 4, "j" : 3 }
   { "_id" : ObjectId("4c220a42f3924d31102bd859"), "x" : 4, "j" : 4 }
   ```

```
{ "_id" : ObjectId("4c220a42f3924d31102bd85a"), "x" : 4, "j" : 5 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85b"), "x" : 4, "j" : 6 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85c"), "x" : 4, "j" : 7 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85d"), "x" : 4, "j" : 8 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85e"), "x" : 4, "j" : 9 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85f"), "x" : 4, "j" : 10 }
{ "_id" : ObjectId("4c220a42f3924d31102bd860"), "x" : 4, "j" : 11 }
{ "_id" : ObjectId("4c220a42f3924d31102bd861"), "x" : 4, "j" : 12 }
{ "_id" : ObjectId("4c220a42f3924d31102bd862"), "x" : 4, "j" : 13 }
{ "_id" : ObjectId("4c220a42f3924d31102bd863"), "x" : 4, "j" : 14 }
{ "_id" : ObjectId("4c220a42f3924d31102bd864"), "x" : 4, "j" : 15 }
{ "_id" : ObjectId("4c220a42f3924d31102bd865"), "x" : 4, "j" : 16 }
{ "_id" : ObjectId("4c220a42f3924d31102bd866"), "x" : 4, "j" : 17 }
{ "_id" : ObjectId("4c220a42f3924d31102bd867"), "x" : 4, "j" : 18 }
```

1. The `find()` (page 820) returns a cursor. To iterate the cursor and return more documents use the `it` operation in the `mongo` (page 908) shell. The `mongo` (page 908) shell will exhaust the cursor, and return the following documents:

   ```
   { "_id" : ObjectId("4c220a42f3924d31102bd868"), "x" : 4, "j" : 19 }
   { "_id" : ObjectId("4c220a42f3924d31102bd869"), "x" : 4, "j" : 20 }
   ```

For more information on inserting new documents, see the *insert()* (page 152) documentation.

1.7.3 Working with the Cursor

When you query a *collection*, MongoDB returns a "cursor" object that contains the results of the query. The `mongo` (page 908) shell then iterates over the cursor to display the results. Rather than returning all results at once, the shell iterates over the cursor 20 times to display the first 20 results and then waits for a request to iterate over the remaining results. This prevents `mongo` (page 908) from displaying thousands or millions of results at once.

The `it` operation allows you to iterate over the next 20 results in the shell. In the *previous procedure* (page 23), the cursor only contained two more documents, and so only two more documents displayed.

The procedures in this section show other ways to work with a cursor. For comprehensive documentation on cursors, see *Iterate the Returned Cursor* (page 165).

Iterate over the Cursor with a Loop

1. In the MongoDB JavaScript shell, query the `things` collection and assign the resulting cursor object to the `c` variable:

   ```
   var c = db.things.find()
   ```

2. Print the full result set by using a `while` loop to iterate over the `c` variable:

   ```
   while ( c.hasNext() ) printjson( c.next() )
   ```

   The `hasNext()` function returns true if the cursor has documents. The `next()` method returns the next document. The `printjson()` method renders the document in a JSON-like format.

   The result of this operation follows, although if the *ObjectId* (page 142) values will be unique:

   ```
   { "_id" : ObjectId("4c2209f9f3924d31102bd84a"), "name" : "mongo" }
   { "_id" : ObjectId("4c2209fef3924d31102bd84b"), "x" : 3 }
   { "_id" : ObjectId("4c220a42f3924d31102bd856"), "x" : 4, "j" : 1 }
   { "_id" : ObjectId("4c220a42f3924d31102bd857"), "x" : 4, "j" : 2 }
   ```

```
{ "_id" : ObjectId("4c220a42f3924d31102bd858"), "x" : 4, "j" : 3 }
{ "_id" : ObjectId("4c220a42f3924d31102bd859"), "x" : 4, "j" : 4 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85a"), "x" : 4, "j" : 5 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85b"), "x" : 4, "j" : 6 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85c"), "x" : 4, "j" : 7 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85d"), "x" : 4, "j" : 8 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85e"), "x" : 4, "j" : 9 }
{ "_id" : ObjectId("4c220a42f3924d31102bd85f"), "x" : 4, "j" : 10 }
{ "_id" : ObjectId("4c220a42f3924d31102bd860"), "x" : 4, "j" : 11 }
{ "_id" : ObjectId("4c220a42f3924d31102bd861"), "x" : 4, "j" : 12 }
{ "_id" : ObjectId("4c220a42f3924d31102bd862"), "x" : 4, "j" : 13 }
{ "_id" : ObjectId("4c220a42f3924d31102bd863"), "x" : 4, "j" : 14 }
{ "_id" : ObjectId("4c220a42f3924d31102bd864"), "x" : 4, "j" : 15 }
{ "_id" : ObjectId("4c220a42f3924d31102bd865"), "x" : 4, "j" : 16 }
{ "_id" : ObjectId("4c220a42f3924d31102bd866"), "x" : 4, "j" : 17 }
{ "_id" : ObjectId("4c220a42f3924d31102bd867"), "x" : 4, "j" : 18 }
{ "_id" : ObjectId("4c220a42f3924d31102bd868"), "x" : 4, "j" : 19 }
{ "_id" : ObjectId("4c220a42f3924d31102bd869"), "x" : 4, "j" : 20 }
```

Use Array Operations with the Cursor

You can manipulate a cursor object as if it were an array. Consider the following procedure:

1. In the `mongo` (page 908) shell, query the `things` collection and assign the resulting cursor object to the `c` variable:

   ```
   var c = db.things.find()
   ```

2. To find the document at the array index `4`, use the following operation:

   ```
   printjson( c [ 4 ] )
   ```

   MongoDB returns the following:

   ```
   { "_id" : ObjectId("4c220a42f3924d31102bd858"), "x" : 4, "j" : 3 }
   ```

   When you access documents in a cursor using the array index notation, `mongo` (page 908) first calls the `cursor.toArray()` method and loads into RAM all documents returned by the cursor. The index is then applied to the resulting array. This operation iterates the cursor completely and exhausts the cursor.

   For very large result sets, `mongo` (page 908) may run out of available memory.

For more information on the cursor, see *Iterate the Returned Cursor* (page 165).

Query for Specific Documents

MongoDB has a rich query system that allows you to select and filter the documents in a collection along specific fields and values. See *Query Document* (page 112) and *Read* (page 159) for a full account of queries in MongoDB.

In this procedure, you query for specific documents in the `things` *collection* by passing a "query document" as a parameter to the `find()` (page 820) method. A query document specifies the criteria the query must match to return a document.

To query for specific documents, do the following:

1. In the `mongo` (page 908) shell, query for all documents where the `name` field has a value of `mongo` by passing the `{ name : "mongo" }` query document as a parameter to the `find()` (page 820) method:

```
db.things.find( { name : "mongo" } )
```

MongoDB returns one document that fits this criteria. The *ObjectId* (page 142) value will be different:

```
{ "_id" : ObjectId("4c2209f9f3924d31102bd84a"), "name" : "mongo" }
```

2. Query for all documents where `x` has a value of `4` by passing the `{ x : 4 }` query document as a parameter to `find()` (page 820):

   ```
   db.things.find( { x : 4 } )
   ```

   MongoDB returns the following result set:

   ```
   { "_id" : ObjectId("4c220a42f3924d31102bd856"), "x" : 4, "j" : 1 }
   { "_id" : ObjectId("4c220a42f3924d31102bd857"), "x" : 4, "j" : 2 }
   { "_id" : ObjectId("4c220a42f3924d31102bd858"), "x" : 4, "j" : 3 }
   { "_id" : ObjectId("4c220a42f3924d31102bd859"), "x" : 4, "j" : 4 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85a"), "x" : 4, "j" : 5 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85b"), "x" : 4, "j" : 6 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85c"), "x" : 4, "j" : 7 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85d"), "x" : 4, "j" : 8 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85e"), "x" : 4, "j" : 9 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85f"), "x" : 4, "j" : 10 }
   { "_id" : ObjectId("4c220a42f3924d31102bd860"), "x" : 4, "j" : 11 }
   { "_id" : ObjectId("4c220a42f3924d31102bd861"), "x" : 4, "j" : 12 }
   { "_id" : ObjectId("4c220a42f3924d31102bd862"), "x" : 4, "j" : 13 }
   { "_id" : ObjectId("4c220a42f3924d31102bd863"), "x" : 4, "j" : 14 }
   { "_id" : ObjectId("4c220a42f3924d31102bd864"), "x" : 4, "j" : 15 }
   { "_id" : ObjectId("4c220a42f3924d31102bd865"), "x" : 4, "j" : 16 }
   { "_id" : ObjectId("4c220a42f3924d31102bd866"), "x" : 4, "j" : 17 }
   { "_id" : ObjectId("4c220a42f3924d31102bd867"), "x" : 4, "j" : 18 }
   { "_id" : ObjectId("4c220a42f3924d31102bd868"), "x" : 4, "j" : 19 }
   { "_id" : ObjectId("4c220a42f3924d31102bd869"), "x" : 4, "j" : 20 }
   ```

   ObjectId (page 142) values are always unique.

3. Query for all documents where `x` has a value of `4`, as in the previous query, but only return only the value of `j`. MongoDB will also return the `_id` field, unless explicitly excluded. To do this, you add the `{ j : 1 }` document as the *projection* in the second parameter to `find()` (page 820). This operation would resemble the following:

   ```
   db.things.find( { x : 4 } , { j : 1 } )
   ```

   MongoDB returns the following results:

   ```
   { "_id" : ObjectId("4c220a42f3924d31102bd856"), "j" : 1 }
   { "_id" : ObjectId("4c220a42f3924d31102bd857"), "j" : 2 }
   { "_id" : ObjectId("4c220a42f3924d31102bd858"), "j" : 3 }
   { "_id" : ObjectId("4c220a42f3924d31102bd859"), "j" : 4 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85a"), "j" : 5 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85b"), "j" : 6 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85c"), "j" : 7 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85d"), "j" : 8 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85e"), "j" : 9 }
   { "_id" : ObjectId("4c220a42f3924d31102bd85f"), "j" : 10 }
   { "_id" : ObjectId("4c220a42f3924d31102bd860"), "j" : 11 }
   { "_id" : ObjectId("4c220a42f3924d31102bd861"), "j" : 12 }
   { "_id" : ObjectId("4c220a42f3924d31102bd862"), "j" : 13 }
   { "_id" : ObjectId("4c220a42f3924d31102bd863"), "j" : 14 }
   { "_id" : ObjectId("4c220a42f3924d31102bd864"), "j" : 15 }
   ```

```
{ "_id" : ObjectId("4c220a42f3924d31102bd865"), "j" : 16 }
{ "_id" : ObjectId("4c220a42f3924d31102bd866"), "j" : 17 }
{ "_id" : ObjectId("4c220a42f3924d31102bd867"), "j" : 18 }
{ "_id" : ObjectId("4c220a42f3924d31102bd868"), "j" : 19 }
{ "_id" : ObjectId("4c220a42f3924d31102bd869"), "j" : 20 }
```

Return a Single Document from a Collection

With the `db.collection.findOne()` (page 825) method you can return a single *document* from a MongoDB collection. The `findOne()` (page 825) method takes the same parameters as `find()` (page 820), but returns a document rather than a cursor.

To retrieve one document from the `things` collection, issue the following command:

```
db.things.findOne()
```

For more information on querying for documents, see the *Read* (page 159) and *Read Operations* (page 111) documentation.

Limit the Number of Documents in the Result Set

You can constrain the size of the result set to increase performance by limiting the amount of data your application must receive over the network.

To specify the maximum number of documents in the result set, call the `limit()` (page 807) method on a cursor, as in the following command:

```
db.things.find().limit(3)
```

MongoDB will return the following result, with different *ObjectId* (page 142) values:

```
{ "_id" : ObjectId("4c2209f9f3924d31102bd84a"), "name" : "mongo" }
{ "_id" : ObjectId("4c2209fef3924d31102bd84b"), "x" : 3 }
{ "_id" : ObjectId("4c220a42f3924d31102bd856"), "x" : 4, "j" : 1 }
```

1.7.4 Next Steps with MongoDB

For more information on manipulating the documents in a database as you continue to learn MongoDB, consider the following resources:

- *CRUD Operations for MongoDB* (page 151)
- *SQL to MongoDB Mapping Chart* (page 874)
- *MongoDB Drivers and Client Libraries* (page 435)
- *Getting Started with MongoDB Development* (page 20)
- *Create* (page 151)
- *Read* (page 159)
- *Update* (page 169)
- *Delete* (page 175)

CHAPTER 2

Release Notes

You should always install the latest, stable version of MongoDB. Stable versions have an even-numbered minor version number. For example: v2.2 is stable, v2.0 and v1.8 were previously the stable, while v2.1 and v2.3 is a development version.

- Current Stable Release:
  - *Release Notes for MongoDB 2.2* (page 1037)
- Previous Stable Releases:
  - *Release Notes for MongoDB 2.0* (page 1046)
  - *Release Notes for MongoDB 1.8* (page 1051)

Part II

Administration

The documentation in this section outlines core administrative tasks and practices that operators of MongoDB will want to consider. In addition to the core topics that follow, also consider the relevant documentation in other sections including: *Sharding* (page 363), *Replication* (page 277), and *Indexes* (page 239).

CHAPTER 3

Run-time Database Configuration

The *command line* (page 897) and *configuration file* (page 944) interfaces provide MongoDB administrators with a large number of options and settings for controlling the operation of the database system. This document provides an overview of common configurations and examples of best-practice configurations for common use cases.

While both interfaces provide access to the same collection of options and settings, this document primarily uses the configuration file interface. If you run MongoDB using a control script or installed from a package for your operating system, you likely already have a configuration file located at `http://docs.mongodb.org/v2.2/etc/mongodb.conf`. Confirm this by checking the content of the `http://docs.mongodb.org/v2.2/etc/init.d/mongod` or `http://docs.mongodb.org/v2.2/etc/rc.d/mongod` script to insure that the *control scripts* start the `mongod` (page 897) with the appropriate configuration file (see below.)

To start MongoDB instance using this configuration issue a command in the following form:

```
mongod --config /etc/mongodb.conf
mongod -f /etc/mongodb.conf
```

Modify the values in the `http://docs.mongodb.org/v2.2/etc/mongodb.conf` file on your system to control the configuration of your database instance.

3.1 Starting, Stopping, and Running the Database

Consider the following basic configuration:

```
fork = true
bind_ip = 127.0.0.1
port = 27017
quiet = true
dbpath = /srv/mongodb
logpath = /var/log/mongodb/mongod.log
logappend = true
journal = true
```

For most standalone servers, this is a sufficient base configuration. It makes several assumptions, but consider the following explanation:

- `fork` (page 947) is `true`, which enables a *daemon* mode for `mongod` (page 897), which detaches (i.e. "forks") the MongoDB from the current session and allows you to run the database as a conventional server.

- bind_ip (page 945) is 127.0.0.1, which forces the server to only listen for requests on the localhost IP. Only bind to secure interfaces that the application-level systems can access with access control provided by system network filtering (i.e. "*firewall*").
- port (page 945) is 27017, which is the default MongoDB port for database instances. MongoDB can bind to any port. You can also filter access based on port using network filtering tools.

  Note: UNIX-like systems require superuser privileges to attach processes to ports lower than 1024.

- quiet (page 951) is true. This disables all but the most critical entries in output/log file. In normal operation this is the preferable operation to avoid log noise. In diagnostic or testing situations, set this value to false. Use setParameter (page 793) to modify this setting during run time.
- dbpath (page 947) is http://docs.mongodb.org/v2.2/srv/mongodb, which specifies where MongoDB will store its data files. http://docs.mongodb.org/v2.2/srv/mongodb and http://docs.mongodb.org/v2.2/var/lib/mongodb are popular locations. The user account that mongod (page 897) runs under will need read and write access to this directory.
- logpath (page 946) is http://docs.mongodb.org/v2.2/var/log/mongodb/mongod.log which is where mongod (page 897) will write its output. If you do not set this value, mongod (page 897) writes all output to standard output (e.g. stdout.)
- logappend (page 946) is true, which ensures that mongod (page 897) does not overwrite an existing log file following the server start operation.
- journal (page 948) is true, which enables *journaling*. Journaling ensures single instance write-durability. 64-bit builds of mongod (page 897) enable journaling by default. Thus, this setting may be redundant.

Given the default configuration, some of these values may be redundant. However, in many situations explicitly stating the configuration increases overall system intelligibility.

3.2 Security Considerations

The following collection of configuration options are useful for limiting access to a mongod (page 897) instance. Consider the following:

```
bind_ip = 127.0.0.1,10.8.0.10,192.168.4.24
nounixsocket = true
auth = true
```

Consider the following explanation for these configuration decisions:

- "bind_ip (page 945)" has three values: 127.0.0.1, the localhost interface; 10.8.0.10, a private IP address typically used for local networks and VPN interfaces; and 192.168.4.24, a private network interface typically used for local networks.

  Because production MongoDB instances need to be accessible from multiple database servers, it is important to bind MongoDB to multiple interfaces that are accessible from your application servers. At the same time it's important to limit these interfaces to interfaces controlled and protected at the network layer.
- "nounixsocket (page 947)" to true disables the UNIX Socket, which is otherwise enabled by default. This limits access on the local system. This is desirable when running MongoDB on systems with shared access, but in most situations has minimal impact.
- "auth (page 947)" is true enables the authentication system within MongoDB. If enabled you will need to log in by connecting over the localhost interface for the first time to create user credentials.

See Also:

Security Practices and Management (page 87)

3.3 Replication and Sharding Configuration

3.3.1 Replication Configuration

Replica set configuration is straightforward, and only requires that the `replSet` (page 952) have a value that is consistent among all members of the set. Consider the following:

```
replSet = set0
```

Use descriptive names for sets. Once configured use the `mongo` (page 908) shell to add hosts to the replica set.

See Also:

Replica set reconfiguration (page 993).

To enable authentication for the *replica set*, add the following option:

```
keyFile = /srv/mongodb/keyfile
```

New in version 1.8: for replica sets, and 1.9.1 for sharded replica sets. Setting `keyFile` (page 947) enables authentication and specifies a key file for the replica set member use to when authenticating to each other. The content of the key file is arbitrary, but must be the same on all members of the *replica set* and `mongos` (page 905) instances that connect to the set. The keyfile must be less than one kilobyte in size and may only contain characters in the base64 set and the file must not have group or "world" permissions on UNIX systems.

See Also:

The "*Replica set Reconfiguration* (page 993)" section for information regarding the process for changing replica set during operation.

Additionally, consider the "*Replica Set Security* (page 294)" section for information on configuring authentication with replica sets.

Finally, see the "*Replication* (page 277)" index and the "*Replica Set Fundamental Concepts* (page 279)" document for more information on replication in MongoDB and replica set configuration in general.

3.3.2 Sharding Configuration

Sharding requires a number of `mongod` (page 897) instances with different configurations. The config servers store the cluster's metadata, while the cluster distributes data among one or more shard servers.

Note: *Config servers* are not *replica sets*.

To set up one or three "config server" instances as *normal* (page 33) `mongod` (page 897) instances, and then add the following configuration option:

```
configsvr = true

bind_ip = 10.8.0.12
port = 27001
```

This creates a config server running on the private IP address `10.8.0.12` on port `27001`. Make sure that there are no port conflicts, and that your config server is accessible from all of your "`mongos` (page 905)" and "`mongod` (page 897)" instances.

To set up shards, configure two or more `mongod` (page 897) instance using your *base configuration* (page 33), adding the `shardsvr` (page 953) setting:

```
shardsvr = true
```

Finally, to establish the cluster, configure at least one `mongos` (page 905) process with the following settings:

```
configdb = 10.8.0.12:27001
chunkSize = 64
```

You can specify multiple `configdb` (page 954) instances by specifying hostnames and ports in the form of a comma separated list. In general, avoid modifying the `chunkSize` (page 954) from the default value of 64, [1] and *should* ensure this setting is consistent among all `mongos` (page 905) instances.

See Also:

The "*Sharding* (page 363)" section of the manual for more information on sharding and cluster configuration.

3.4 Running Multiple Database Instances on the Same System

In many cases running multiple instances of `mongod` (page 897) on a single system is not recommended. On some types of deployments [2] and for testing purposes you may need to run more than one `mongod` (page 897) on a single system.

In these cases, use a *base configuration* (page 33) for each instance, but consider the following configuration values:

```
dbpath = /srv/mongodb/db0/
pidfilepath = /srv/mongodb/db0.pid
```

The `dbpath` (page 947) value controls the location of the `mongod` (page 897) instance's data directory. Ensure that each database has a distinct and well labeled data directory. The `pidfilepath` (page 947) controls where `mongod` (page 897) process places it's *process id* file. As this tracks the specific `mongod` (page 897) file, it is crucial that file be unique and well labeled to make it easy to start and stop these processes.

Create additional *control scripts* and/or adjust your existing MongoDB configuration and control script as needed to control these processes.

3.5 Diagnostic Configurations

The following configuration options control various `mongod` (page 897) behaviors for diagnostic purposes. The following settings have default values that tuned for general production purposes:

```
slowms = 50
profile = 3
verbose = true
diaglog = 3
objcheck = true
cpu = true
```

[1] *Chunk* size is 64 megabytes by default, which provides the ideal balance between the most even distribution of data, for which smaller chunk sizes are best, and minimizing chunk migration, for which larger chunk sizes are optimal.

[2] Single-tenant systems with *SSD* or other high performance disks may provide acceptable performance levels for multiple `mongod` (page 897) instances. Additionally, you may find that multiple databases with small working sets may function acceptably on a single system.

Use the *base configuration* (page 33) and add these options if you are experiencing some unknown issue or performance problem as needed:

- `slowms` (page 950) configures the threshold for the *database profiler* to consider a query "slow." The default value is 100 milliseconds. Set a lower value if the database profiler does not return useful results. See *Optimization Strategies for MongoDB Applications* (page 435) for more information on optimizing operations in MongoDB.
- `profile` (page 949) sets the *database profiler* level. The profiler is not active by default because of the possible impact on the profiler itself on performance. Unless this setting has a value, queries are not profiled.
- `verbose` (page 945) enables a verbose logging mode that modifies `mongod` (page 897) output and increases logging to include a greater number of events. Only use this option if you are experiencing an issue that is not reflected in the normal logging level. If you require additional verbosity, consider the following options:

  ```
  v = true
  vv = true
  vvv = true
  vvvv = true
  vvvvv = true
  ```

  Each additional level `v` adds additional verbosity to the logging. The `verbose` option is equal to `v = true`.
- `diaglog` (page 948) enables *diagnostic logging*. Level `3` logs all read and write options.
- `objcheck` (page 946) forces `mongod` (page 897) to validate all requests from clients upon receipt. Use this option to ensure that invalid requests are not causing errors, particularly when running a database with untrusted clients. This option may affect database performance.
- `cpu` (page 947) forces `mongod` (page 897) to report the percentage of the last interval spent in *write-lock*. The interval is typically 4 seconds, and each output line in the log includes both the actual interval since the last report and the percentage of time spent in write lock.

CHAPTER 4

Operational Segregation in MongoDB Operations and Deployments

4.1 Operational Overview

MongoDB includes a cluster of features that allow database administrators and developers to segregate application operations to MongoDB deployments by functional or geographical groupings.

This capability provides "data center awareness," which allows applications to target MongoDB deployments with consideration of the physical location of `mongod` (page 897) instances. MongoDB supports segmentation of operations across different dimensions, which may include multiple data centers and geographical regions in multi-data center deployments or racks, networks, or power circuits in single data center deployments.

MongoDB also supports segregation of database operations based on functional or operational parameters, to ensure that certain `mongod` (page 897) instances are only used for reporting workloads or that certain high-frequency portions of a sharded collection only exist on specific shards.

Specifically, with MongoDB, you can:

- ensure write operations propagate to specific members of a replica set, or to specific members of replica sets.
- ensure that specific members of a replica set respond to queries.
- ensure that specific ranges of your *shard key* balance onto and reside on specific *shards*.
- combine the above features in a single distributed deployment, on a per-operation (for read and write operations) and collection (for chunk distribution in sharded clusters distribution) basis.

For full documentation of these features, see the following documentation in the MongoDB Manual:

- *Read Preferences* (page 306), which controls how drivers help applications target read operations to members of a replica set.
- *Write Concerns* (page 303), which controls how MongoDB ensures that write operations propagate to members of a replica set.
- *Replica Set Tags* (page 994), which control how applications create and interact with custom groupings of replica set members to create custom application-specific read preferences and write concerns.
- *Tag Aware Sharding* (page 408), which allows MongoDB administrators to define an application-specific balancing policy, to control how documents belonging to specific ranges of a shard key distribute to shards in the *sharded cluster*.

See Also:

Before adding operational segregation features to your application and MongoDB deployment, become familiar with all documentation of *replication* (page 277) and *sharding* (page 363), particularly *Replica Set Fundamental Concepts* (page 279) and *Sharded Cluster Overview* (page 365).

CHAPTER 5

Journaling

MongoDB uses *write ahead logging* to an on-disk *journal* to guarantee *write operation* (page 123) durability and to provide crash resiliency. Before applying a change to the data files, MongoDB writes the change operation to the journal. If MongoDB should terminate or encounter an error before it can write the changes from the journal to the data files, MongoDB can re-apply the write operation and maintain a consistent state.

Without a journal, if `mongod` (page 897) exits unexpectedly, you must assume your data is in an inconsistent state, and you must run either *repair* (page 596) or, preferably, *resync* (page 293) from a clean member of the replica set.

With journaling enabled, if `mongod` (page 897) stops unexpectedly, the program can recover everything written to the journal, and the data remains in a consistent state. By default, the greatest extent of lost writes, i.e., those not made to the journal, is no more than the last 100 milliseconds.

With journaling, if you want a data set to reside entirely in RAM, you need enough RAM to hold the dataset plus the "write working set." The "write working set" is the amount of unique data you expect to see written between re-mappings of the private view. For information on views, see *Storage Views used in Journaling* (page 44).

Important: Changed in version 2.0: For 64-bit builds of `mongod` (page 897), journaling is enabled by default. For other platforms, see `journal` (page 948).

5.1 Procedures

5.1.1 Enable Journaling

Changed in version 2.0: For 64-bit builds of `mongod` (page 897), journaling is enabled by default. To enable journaling, start `mongod` (page 897) with the `--journal` (page 900) command line option.

If no journal files exist, when `mongod` (page 897) starts, it must preallocate new journal files. During this operation, the `mongod` (page 897) is not listening for connections until preallocation completes: for some systems this may take a several minutes. During this period your applications and the `mongo` (page 908) shell are not available.

5.1.2 Disable Journaling

Warning: Do not disable journaling on production systems. If your mongod (page 897) instance stops without shutting down cleanly unexpectedly for any reason, (e.g. power failure) and you are not running with journaling, then you must recover from an unaffected *replica set* member or backup, as described in *repair* (page 596).

To disable journaling, start mongod (page 897) with the *--nojournal* (page 900) command line option.

5.1.3 Get Commit Acknowledgment

You can get commit acknowledgment with the getLastError (page 766) command and the j option. For details, see *Internal Operation of Write Concern* (page 125).

5.1.4 Avoid Preallocation Lag

To avoid *preallocation lag* (page 43), you can preallocate files in the journal directory by copying them from another instance of mongod (page 897).

Preallocated files do not contain data. It is safe to later remove them. But if you restart mongod (page 897) with journaling, mongod (page 897) will create them again.

Example

The following sequence preallocates journal files for an instance of mongod (page 897) running on port 27017 with a database path of http://docs.mongodb.org/v2.2/data/db.

For demonstration purposes, the sequence starts by creating a set of journal files in the usual way.

1. Create a temporary directory into which to create a set of journal files:

   ```
   mkdir ~/tmpDbpath
   ```

2. Create a set of journal files by staring a mongod (page 897) instance that uses the temporary directory:

   ```
   mongod --port 10000 --dbpath ~/tmpDbpath --journal
   ```

3. When you see the following log output, indicating mongod (page 897) has the files, press CONTROL+C to stop the mongod (page 897) instance:

   ```
   web admin interface listening on port 11000
   ```

4. Preallocate journal files for the new instance of mongod (page 897) by moving the journal files from the data directory of the existing instance to the data directory of the new instance:

   ```
   mv ~/tmpDbpath/journal /data/db/
   ```

5. Start the new mongod (page 897) instance:

   ```
   mongod --port 27017 --dbpath /data/db --journal
   ```

5.1.5 Monitor Journal Status

Use the following commands and methods to monitor journal status:

- `serverStatus` (page 792)

  The `serverStatus` (page 792) command returns database status information that is useful for assessing performance.

- `journalLatencyTest` (page 774)

  Use `journalLatencyTest` (page 774) to measure how long it takes on your volume to write to the disk in an append-only fashion. You can run this command on an idle system to get a baseline sync time for journaling. You can also run this command on a busy system to see the sync time on a busy system, which may be higher if the journal directory is on the same volume as the data files.

  The `journalLatencyTest` (page 774) command also provides a way to check if your disk drive is buffering writes in its local cache. If the number is very low (i.e., less than 2 milliseconds) and the drive is non-SSD, the drive is probably buffering writes. In that case, enable cache write-through for the device in your operating system, unless you have a disk controller card with battery backed RAM.

5.1.6 Change the Group Commit Interval

Changed in version 2.0. You can set the group commit interval using the `--journalCommitInterval` (page 900) command line option. The allowed range is `2` to `300` milliseconds.

Lower values increase the durability of the journal at the expense of disk performance.

5.1.7 Recover Data After Unexpected Shutdown

On a restart after a crash, MongoDB replays all journal files in the journal directory before the server becomes available. If MongoDB must replay journal files, `mongod` (page 897) notes these events in the log output.

There is no reason to run `repairDatabase` (page 787) in these situations.

5.2 Journaling Internals

When running with journaling, MongoDB stores and applies *write operations* (page 123) in memory and in the journal before the changes are in the data files.

5.2.1 Journal Files

With journaling enabled, MongoDB creates a journal directory within the directory defined by `dbpath` (page 947), which is `http://docs.mongodb.org/v2.2/data/db` by default. The journal directory holds journal files, which contain write-ahead redo logs. The directory also holds a last-sequence-number file. A clean shutdown removes all the files in the journal directory.

Journal files are append-only files and have file names prefixed with `j._`. When a journal file holds 1 gigabyte of data, MongoDB creates a new journal file. Once MongoDB applies all the write operations in the journal files, it deletes these files. Unless you write *many* bytes of data per-second, the journal directory should contain only two or three journal files.

To limit the size of each journal file to 128 megabytes, use the `smallfiles` (page 950) run time option when starting `mongod` (page 897).

To speed the frequent sequential writes that occur to the current journal file, you can ensure that the journal directory is on a different system.

Important: If you place the journal on a different filesystem from your data files you *cannot* use a filesystem snapshot to capture consistent backups of a `dbpath` (page 947) directory.

Note: Depending on your file system, you might experience a preallocation lag the first time you start a `mongod` (page 897) instance with journaling enabled. MongoDB preallocates journal files if it is faster on your file system to create files of a pre-defined. The amount of time required to pre-allocate lag might last several minutes, during which you will not be able to connect to the database. This is a one-time preallocation and does not occur with future invocations.

To avoid preallocation lag, see *Avoid Preallocation Lag* (page 42).

5.2.2 Storage Views used in Journaling

Journaling adds three storage views to MongoDB.

The `shared view` stores modified data for upload to the MongoDB data files. The `shared view` is the only view with direct access to the MongoDB data files. When running with journaling, `mongod` (page 897) asks the operating system to map your existing on-disk data files to the `shared view` memory view. The operating system maps the files but does not load them. MongoDB later loads data files to `shared view` as needed.

The `private view` stores data for use in *read operations* (page 111). MongoDB maps `private view` to the `shared view` and is the first place MongoDB applies new *write operations* (page 123).

The journal is an on-disk view that stores new write operations after MongoDB applies the operation to the `private cache` but before applying them to the data files. The journal provides durability. If the `mongod` (page 897) instance were to crash without having applied the writes to the data files, the journal could replay the writes to the `shared view` for eventual upload to the data files.

5.2.3 How Journaling Records Write Operations

MongoDB copies the write operations to the journal in batches called group commits. By default, MongoDB performs a group commit every 100 milliseconds: as a result MongoDB commits all operations within a 100 millisecond window in a single batch. These "group commits" help minimize the performance impact of journaling.

Journaling stores raw operations that allow MongoDB to reconstruct the following:

- document insertion/updates
- index modifications
- changes to the namespace files

As *write operations* (page 123) occur, MongoDB writes the data to the `private view` in RAM and then copies the write operations in batches to the journal. The journal stores the operations on disk to ensure durability. MongoDB adds the operations as entries on the journal's forward pointer. Each entry describes which bytes the write operation changed in the data files.

MongoDB next applies the journal's write operations to the `shared view`. At this point, the `shared view` becomes inconsistent with the data files.

At default intervals of 60 seconds, MongoDB asks the operating system to flush the `shared view` to disk. This brings the data files up-to-date with the latest write operations.

When MongoDB flushes write operations to the data files, MongoDB removes the write operations from the journal's behind pointer. The behind pointer is always far back from advanced pointer.

As part of journaling, MongoDB routinely asks the operating system to remap the `shared view` to the `private view`, for consistency.

Note: The interaction between the `shared view` and the on-disk data files is similar to how MongoDB works *without* journaling, which is that MongoDB asks the operating system to flush in-memory changes back to the data files every 60 seconds.

Use MongoDB with SSL Connections

This document outlines the use and operation of MongoDB's SSL support. SSL allows MongoDB clients to support encrypted connections to mongod (page 897) instances.

Note: The default distribution of MongoDB does **not** contain support for SSL.

As of the current release, to use SSL you must either: build MongoDB locally passing the "--ssl" option to scons, or use the MongoDB subscriber build.

These instructions outline the process for getting started with SSL and assume that you have already installed a build of MongoDB that includes SSL support and that your client driver supports SSL.

6.1 mongod and mongos SSL Configuration

Add the following command line options to your mongod (page 897) invocation:

```
mongod --sslOnNormalPorts --sslPEMKeyFile <pem> --sslPEMKeyPassword <pass>
```

Replace "<pem>" with the path to your SSL certificate .pem file, and "<pass>" with the password you used to encrypt the .pem file.

You may also specify these options in your "mongodb.conf" file, as in the following:

```
sslOnNormalPorts = true
sslPEMKeyFile = /etc/ssl/mongodb.pem
sslPEMKeyPassword = pass
```

Modify these values to reflect the location of your actual .pem file and its password.

You can specify these configuration options in a configuration file for mongos (page 905), or start mongos (page 905) with the following invocation:

```
mongos --sslOnNormalPorts --sslPEMKeyFile <pem> --sslPEMKeyPassword <pass>
```

You can use any existing SSL certificate, or you can generate your own SSL certificate using a command that resembles the following:

```
cd /etc/ssl/
openssl req -new -x509 -days 365 -nodes -out mongodb-cert.pem -keyout mongodb-cert.key
```

To create the combined `.pem` file that contains the `.key` file and the `.pem` certificate, use the following command:

```
cat mongodb-cert.key mongodb-cert.pem > mongodb.pem
```

6.2 Clients

Clients must have support for SSL to work with a `mongod` (page 897) instance that has SSL support enabled. The current versions of the Python, Java, Ruby, Node.js, and .NET drivers have support for SSL, with full support coming in future releases of other drivers.

6.2.1 mongo

The `mongo` (page 908) shell built with ssl support distributed with the subscriber build also supports SSL. Use the "`--ssl`" flag as follows:

```
mongo --ssl --host <host>
```

6.2.2 MMS

The MMS agent will also have to connect via SSL in order to gather its stats. Because the agent already utilizes SSL for its communications to the MMS servers, this is just a matter of enabling SSL support in MMS itself on a per host basis.

Use the "Edit" host button (i.e. the pencil) on the Hosts page in the MMS console and is currently enabled on a group by group basis by 10gen.

Please see the MMS Manual for more information about MMS configuration.

6.2.3 PyMongo

Add the "`ssl=True`" parameter to a PyMongo `MongoClient` to create a MongoDB connection to an SSL MongoDB instance:

```
from pymongo import MongoClient
c = MongoClient(host="mongodb.example.net", port=27017, ssl=True)
```

To connect to a replica set, use the following operation:

```
from pymongo import MongoReplicaSetClient
c = MongoReplicaSetClient("mongodb.example.net:27017",
                          replicaSet="mysetname", ssl=True)
```

PyMongo also supports an "`ssl=true`" option for the MongoDB URI:

```
mongodb://mongodb.example.net:27017/?ssl=true
```

6.2.4 Java

Consider the following example "`SSLApp.java`" class file:

```
import com.mongodb.*;
import javax.net.ssl.SSLSocketFactory;

public class SSLApp {

    public static void main(String args[])  throws Exception {

        MongoClientOptions o = new MongoClientOptions.Builder()
                .socketFactory(SSLSocketFactory.getDefault())
                .build();

        MongoClient m = new MongoClient("localhost", o);

        DB db = m.getDB( "test" );
        DBCollection c = db.getCollection( "foo" );

        System.out.println( c.findOne() );
    }
}
```

6.2.5 Ruby

The recent versions of the Ruby driver have support for connections to SSL servers. Install the latest version of the driver with the following command:

```
gem install mongo
```

Then connect to a standalone instance, using the following form:

```
require 'rubygems'
require 'mongo'

connection = Mongo::Connection.new('localhost', 27017, :ssl => true)
```

Replace `connection` with the following if you're connecting to a replica set:

```
connection = Mongo::ReplSetConnection.new(['localhost:27017'],
                                          ['localhost:27018'],
                                          :ssl => true)
```

Here, `mongod` (page 897) instance run on "`localhost:27017`" and "`localhost:27018`".

6.2.6 Node.JS (`node-mongodb-native`)

In the node-mongodb-native driver, use the following invocation to connect to a `mongod` (page 897) or `mongos` (page 905) instance via SSL:

```
var db1 = new Db(MONGODB, new Server("127.0.0.1", 27017,
                                     { auto_reconnect: false, poolSize:4, ssl:ssl } );
```

To connect to a replica set via SSL, use the following form:

```
var replSet = new ReplSetServers( [
    new Server( RS.host, RS.ports[1], { auto_reconnect: true } ),
    new Server( RS.host, RS.ports[0], { auto_reconnect: true } ),
    ],
```

```
  {rs_name:RS.name, ssl:ssl}
);
```

6.2.7 .NET

As of release 1.6, the .NET driver supports SSL connections with `mongod` (page 897) and `mongos` (page 905) instances. To connect using SSL, you must add an option to the connection string, specifying `ssl=true` as follows:

```
var connectionString = "mongodb://localhost/?ssl=true";
var server = MongoServer.Create(connectionString);
```

The .NET driver will validate the certificate against the local trusted certificate store, in addition to providing encryption of the server. This behavior may produce issues during testing, if the server uses a self-signed certificate. If you encounter this issue, add the `sslverifycertificate=false` option to the connection string to prevent the .NET driver from validating the certificate, as follows:

```
var connectionString = "mongodb://localhost/?ssl=true&sslverifycertificate=false";
var server = MongoServer.Create(connectionString);
```

CHAPTER 7

Use MongoDB with SNMP Monitoring

New in version 2.2.

Subscriber Only Feature

This feature is only available in the Subscriber Edition of MongoDB.

This document outlines the use and operation of MongoDB's SNMP extension, which is is only available in the MongoDB Subscriber Edition.

7.1 Prerequisites

7.1.1 Install MongoDB Subscriber Edition

The MongoDB Subscriber Edition, is available on four platforms. For more information, see MongoDB Subscriber Edition.

7.1.2 Included Files

The Subscriber Edition packages contain the following files:

- `MONGO-MIB.txt`:

  The `MIB` file that describes the data (i.e. schema) for MongoDB's SNMP output

- `mongod.conf`:

  The SNMP configuration file for reading the SNMP output of MongoDB. The SNMP configures the community names, permissions, access controls, etc.

7.1.3 Required Packages

To use SNMP, you must install several prerequisites. The names of the packages vary by distribution and are as follows:

- Ubuntu 11.04 requires `libssl0.9.8`, `snmp-mibs-downloader`, `snmp`, and `snmpd`. Issue a command such as the following to install these packages:

  ```
  sudo apt-get install libssl0.9.8 snmp snmpd snmp-mibs-downloader
  ```

- Red Hat Enterprise Linux 6.x series and Amazon Linux AMI require `libssl`, `net-snmp`, `net-snmp-libs`, and `net-snmp-utils`. Issue a command such as the following to install these packages:

  ```
  sudo yum install libssl net-snmp net-snmp-libs net-snmp-utils
  ```

- SUSE Enterprise Linux requires `libopenssl0_9_8`, `libsnmp15`, `slessp1-libsnmp15`, and `snmp-mibs`. Issue a command such as the following to install these packages:

  ```
  sudo zypper install libopenssl0_9_8 libsnmp15 slessp1-libsnmp15 snmp-mibs
  ```

7.2 Configure SNMP

7.2.1 Install MIB Configuration Files

Ensure that the MIB directory, at `http://docs.mongodb.org/v2.2/usr/share/snmp/mibs` exists. If not, issue the following command:

```
sudo mkdir -p /usr/share/snmp/mibs
```

Use the following command to create a symbolic link:

```
sudo ln -s [/path/to/mongodb/distribution/]MONGO-MIB.txt /usr/share/snmp/mibs/
```

Replace `[/path/to/mongodb/distribution/]` with the path to your `MONGO-MIB.txt` configuration file.

Copy the `mongod.conf` file into the `http://docs.mongodb.org/v2.2/etc/snmp` directory with the following command:

```
cp mongod.conf /etc/snmp/mongod.conf
```

7.2.2 Start Up

You can control the Subscriber Edition of MongoDB using default or custom or control scripts, just as you can any other **mongod**:

Use the following command to view all SNMP options available in your MongoDB:

```
mongod --help | grep snmp
```

The above command should return the following output:

```
Module snmp options:
  --snmp-subagent       run snmp subagent
  --snmp-master         run snmp as master
```

Ensure that the following directories exist:

- `http://docs.mongodb.org/v2.2/data/db/` (This is the path where MongoDB stores the data files.)
- `http://docs.mongodb.org/v2.2/var/log/mongodb/` (This is the path where MongoDB writes the log output.)

If they do not, issue the following command:

```
mkdir -p /var/log/mongodb/ /data/db/
```

Start the **mongod** instance with the following command:

```
mongod --snmp-master --port 3001 --fork --dbpath /data/db/  --logpath /var/log/mongodb/1.log
```

Optionally, you can set these options in a *configuration file* (page 944).

To check if **mongod** is running with SNMP support, issue the following command:

```
ps -ef | grep 'mongod --snmp'
```

The command should return output that includes the following line. This indicates that the proper **mongod** instance is running:

```
systemuser 31415 10260  0 Jul13 pts/16   00:00:00 mongod --snmp-master --port 3001 # [...]
```

7.2.3 Test SNMP

Check for the snmp agent process listening on port `1161` with the following command:

```
sudo lsof -i :1161
```

which return the following output:

```
COMMAND  PID     USER   FD   TYPE DEVICE SIZE/OFF NODE NAME
mongod  9238 sysadmin   10u  IPv4  96469      0t0  UDP localhost:health-polling
```

Similarly, this command:

```
netstat -an | grep 1161
```

should return the following output:

```
udp        0      0 127.0.0.1:1161              0.0.0.0:*
```

7.2.4 Run `snmpwalk` Locally

`snmpwalk` provides tools for retrieving and parsing the SNMP data according to the MIB. If you installed all of the required packages above, your system will have `snmpwalk`.

Issue the following command to collect data from **mongod** using SNMP:

```
snmpwalk -m MONGO-MIB -v 2c -c mongodb 127.0.0.1:1161 1.3.6.1.4.1.37601
```

You may also choose to specify a the path to the MIB file:

```
snmpwalk -m /usr/share/snmp/mibs/MONGO-MIB -v 2c -c mongodb 127.0.0.1:1161 1.3.6.1.4.1.37601
```

Use this command *only* to ensure that you can retrieve and validate SNMP data from MongoDB.

7.3 Troubleshooting

Always check the logs for errors if something does not run as expected, see the log at `http://docs.mongodb.org/v2.2/var/log/mongodb/1.log`. The presence of the following line

indicates that the **mongod** cannot read the `http://docs.mongodb.org/v2.2/etc/snmp/mongod.conf` file:

```
[SNMPAgent] warning: error starting SNMPAgent as master err:1
```

CHAPTER 8

Monitoring Database Systems

Monitoring is a critical component of all database administration. A firm grasp of MongoDB's reporting will allow you to assess the state of your database and maintain your deployment without crisis. Additionally, a sense of MongoDB's normal operational parameters will allow you to diagnose issues as you encounter them, rather than waiting for a crisis or failure.

This document provides an overview of the available tools and data provided by MongoDB as well as an introduction to diagnostic strategies, and suggestions for monitoring instances in MongoDB's replica sets and sharded clusters.

Note: 10gen provides a hosted monitoring service which collects and aggregates these data to provide insight into the performance and operation of MongoDB deployments. See the MongoDB Monitoring Service (MMS) and the MMS documentation for more information.

8.1 Monitoring Tools

There are two primary methods for collecting data regarding the state of a running MongoDB instance. First, there are a set of tools distributed with MongoDB that provide real-time reporting of activity on the database. Second, several *database commands* (page 885) return statistics regarding the current database state with greater fidelity. Both methods allow you to collect data that answers a different set of questions, and are useful in different contexts.

This section provides an overview of these utilities and statistics, along with an example of the kinds of questions that each method is most suited to help you address.

8.1.1 Utilities

The MongoDB distribution includes a number of utilities that return statistics about instances' performance and activity quickly. These are typically most useful for diagnosing issues and assessing normal operation.

mongotop

`mongotop` (page 935) tracks and reports the current read and write activity of a MongoDB instance. `mongotop` (page 935) provides per-collection visibility into use. Use `mongotop` (page 935) to verify that activity and use match expectations. See the *mongotop manual* (page 935) for details.

mongostat

mongostat (page 931) captures and returns counters of database operations. mongostat (page 931) reports operations on a per-type (e.g. insert, query, update, delete, etc.) basis. This format makes it easy to understand the distribution of load on the server. Use mongostat (page 931) to understand the distribution of operation types and to inform capacity planning. See the *mongostat manual* (page 931) for details.

REST Interface

MongoDB provides a *REST* interface that exposes a diagnostic and monitoring information in a simple web page. Enable this by setting rest (page 950) to true, and access this page via the local host interface using the port numbered 1000 more than that the database port. In default configurations the REST interface is accessible on 28017. For example, to access the REST interface on a locally running mongod instance: http://localhost:28017

8.1.2 Statistics

MongoDB provides a number of commands that return statistics about the state of the MongoDB instance. These data may provide finer granularity regarding the state of the MongoDB instance than the tools above. Consider using their output in scripts and programs to develop custom alerts, or to modify the behavior of your application in response to the activity of your instance.

serverStatus

Access *serverStatus data* (page 965) by way of the serverStatus (page 792) command. This *document* contains a general overview of the state of the database, including disk usage, memory use, connection, journaling, index accesses. The command returns quickly and does not impact MongoDB performance.

While this output contains a (nearly) complete account of the state of a MongoDB instance, in most cases you will not run this command directly. Nevertheless, all administrators should be familiar with the data provided by serverStatus (page 792).

See Also:

db.serverStatus() (page 854) and *serverStatus data* (page 965).

replSetGetStatus

View the *replSetGetStatus data* (page 987) with the replSetGetStatus (page 788) command (rs.status() (page 861) from the shell). The document returned by this command reflects the state and configuration of the replica set. Use this data to ensure that replication is properly configured, and to check the connections between the current host and the members of the replica set.

dbStats

The *dbStats data* (page 979) is accessible by way of the dbStats (page 753) command (db.stats() (page 855) from the shell). This command returns a document that contains data that reflects the amount of storage used and data contained in the database, as well as object, collection, and index counters. Use this data to check and track the state and storage of a specific database. This output also allows you to compare utilization between databases and to determine average *document* size in a database.

collStats

The *collStats data* (page 980) is accessible using the `collStats` (page 745) command (`db.printCollectionStats()` (page 851) from the shell). It provides statistics that resemble `dbStats` (page 753) on the collection level: this includes a count of the objects in the collection, the size of the collection, the amount of disk space used by the collection, and information about the indexes.

8.1.3 Introspection Tools

In addition to status reporting, MongoDB provides a number of introspection tools that you can use to diagnose and analyze performance and operational conditions. Consider the following documentation:

- `diagLogging` (page 753)
- *Analyze Performance of Database Operations* (page 616)
- *Database Profiler Output* (page 1003)
- *Current Operation Reporting* (page 998)

8.1.4 Third Party Tools

A number of third party monitoring tools have support for MongoDB, either directly, or through their own plugins.

Self Hosted Monitoring Tools

These are monitoring tools that you must install, configure and maintain on your own servers, usually open source.

Tool	Plugin	Description
Ganglia	mongodb-ganglia	Python script to report operations per second, memory usage, btree statistics, master/slave status and current connections.
Ganglia	gmond_python_modules	Parses output from the `serverStatus` (page 792) and `replSetGetStatus` (page 788) commands.
Motop	*None*	Realtime monitoring tool for several MongoDB servers. Shows current operations ordered by durations every second.
mtop	*None*	A top like tool.
Munin	mongo-munin	Retrieves server statistics.
Munin	mongomon	Retrieves collection statistics (sizes, index sizes, and each (configured) collection count for one DB).
Munin	munin-plugins Ubuntu PPA	Some additional munin plugins not in the main distribution.
Nagios	nagios-plugin-mongodb	A simple Nagios check script, written in Python.
Zabbix	mikoomi-mongodb	Monitors availability, resource utilization, health, performance and other important metrics.

Also consider dex, an index and query analyzing tool for MongoDB that compares MongoDB log files and indexes to make indexing recommendations.

Hosted (SaaS) Monitoring Tools

These are monitoring tools provided as a hosted service, usually on a subscription billing basis.

Name	Notes
Scout	Several plugins including: MongoDB Monitoring, MongoDB Slow Queries and MongoDB Replica Set Monitoring.
Server Density	Dashboard for MongoDB, MongoDB specific alerts, replication failover timeline and iPhone, iPad and Android mobile apps.

8.2 Process Logging

During normal operation, `mongod` (page 897) and `mongos` (page 905) instances report information that reflect current operation to standard output, or a log file. The following runtime settings control these options.

- `quiet` (page 951). Limits the amount of information written to the log or output.
- `verbose` (page 945). Increases the amount of information written to the log or output.

  You can also specify this as `v` (as in `-v`.) Set multiple `v`, as in `vvvv = True` for higher levels of verbosity. You can also change the verbosity of a running `mongod` (page 897) or `mongos` (page 905) instance with the `setParameter` (page 793) command.
- `logpath` (page 946). Enables logging to a file, rather than standard output. Specify the full path to the log file to this setting..
- `logappend` (page 946). Adds information to a log file instead of overwriting the file.

Note: You can specify these configuration operations as the command line arguments to *mongod* (page 897) or *mongos* (page 904)

Additionally, the following *database commands* affect logging:

- `getLog` (page 767). Displays recent messages from the `mongod` (page 897) process log.
- `logRotate` (page 775). Rotates the log files for `mongod` (page 897) processes only. See *Rotate Log Files* (page 620).

8.3 Diagnosing Performance Issues

Degraded performance in MongoDB can be the result of an array of causes, and is typically a function of the relationship among the quantity of data stored in the database, the amount of system RAM, the number of connections to the database, and the amount of time the database spends in a lock state.

In some cases performance issues may be transient and related to traffic load, data access patterns, or the availability of hardware on the host system for virtualized environments. Some users also experience performance limitations as a result of inadequate or inappropriate indexing strategies, or as a consequence of poor schema design patterns. In other situations, performance issues may indicate that the database may be operating at capacity and that it is time to add additional capacity to the database.

8.3.1 Locks

MongoDB uses a locking system to ensure consistency. However, if certain operations are long-running, or a queue forms, performance slows as requests and operations wait for the lock. Because lock related slow downs can be intermittent, look to the data in the *globalLock* (page 968) section of the `serverStatus` (page 792) response to assess if the lock has been a challenge to your performance. If `globalLock.currentQueue.total` (page 969)

is consistently high, then there is a chance that a large number of requests are waiting for a lock. This indicates a possible concurrency issue that might affect performance.

If `globalLock.totalTime` (page 968) is high in context of `uptime` (page 966) then the database has existed in a lock state for a significant amount of time. If `globalLock.ratio` (page 969) is also high, MongoDB has likely been processing a large number of long running queries. Long queries are often the result of a number of factors: ineffective use of indexes, non-optimal schema design, poor query structure, system architecture issues, or insufficient RAM resulting in *page faults* (page 59) and disk reads.

8.3.2 Memory Usage

Because MongoDB uses memory mapped files to store data, given a data set of sufficient size, the MongoDB process will allocate all memory available on the system for its use. Because of the way operating systems function, the amount of allocated RAM is not a useful reflection of MongoDB's state.

While this is part of the design, and affords MongoDB superior performance, the memory mapped files make it difficult to determine if the amount of RAM is sufficient for the data set. Consider *memory usage statuses* (page 969) to better understand MongoDB's memory utilization. Check the resident memory use (i.e. `mem.resident` (page 970):) if this exceeds the amount of system memory *and* there's a significant amount of data on disk that isn't in RAM, you may have exceeded the capacity of your system.

Also check the amount of mapped memory (i.e. `mem.mapped` (page 970).) If this value is greater than the amount of system memory, some operations will require disk access *page faults* to read data from virtual memory with deleterious effects on performance.

8.3.3 Page Faults

Page faults represent the number of times that MongoDB requires data not located in physical memory, and must read from virtual memory. To check for page faults, see the `extra_info.page_faults` (page 971) value in the `serverStatus` (page 792) command. This data is only available on Linux systems.

Alone, page faults are minor and complete quickly; however, in aggregate, large numbers of page fault typically indicate that MongoDB is reading too much data from disk and can indicate a number of underlying causes and recommendations. In many situations, MongoDB's read locks will "yield" after a page fault to allow other processes to read and avoid blocking while waiting for the next page to read into memory. This approach improves concurrency, and in high volume systems this also improves overall throughput.

If possible, increasing the amount of RAM accessible to MongoDB may help reduce the number of page faults. If this is not possible, you may want to consider deploying a *sharded cluster* and/or adding one or more *shards* to your deployment to distribute load among `mongod` (page 897) instances.

8.3.4 Number of Connections

In some cases, the number of connections between the application layer (i.e. clients) and the database can overwhelm the ability of the server to handle requests which can produce performance irregularities. Check the following fields in the *serverStatus* (page 965) document:

- `globalLock.activeClients` (page 969) contains a counter of the total number of clients with active operations in progress or queued.
- `connections` (page 970) is a container for the following two fields:
  - `current` (page 970) the total number of current clients that connect to the database instance.
  - `available` (page 970) the total number of unused collections available for new clients.

Note: Unless limited by system-wide limits MongoDB has a hard connection limit of 20 thousand connections. You can modify system limits using the `ulimit` command, or by editing your system's `http://docs.mongodb.org/v2.2/etc/sysctl` file.

If requests are high because there are many concurrent application requests, the database may have trouble keeping up with demand. If this is the case, then you will need to increase the capacity of your deployment. For read-heavy applications increase the size of your *replica set* and distribute read operations to *secondary* members. For write heavy applications, deploy *sharding* and add one or more *shards* to a *sharded cluster* to distribute load among `mongod` (page 897) instances.

Spikes in the number of connections can also be the result of application or driver errors. All of the MongoDB drivers supported by 10gen implement connection pooling, which allows clients to use and reuse connections more efficiently. Extremely high numbers of connections, particularly without corresponding workload is often indicative of a driver or other configuration error.

8.3.5 Database Profiling

MongoDB contains a database profiling system that can help identify inefficient queries and operations. Enable the profiler by setting the `profile` (page 783) value using the following command in the `mongo` (page 908) shell:

```
db.setProfilingLevel(1)
```

See Also:

The documentation of `db.setProfilingLevel()` (page 854) for more information about this command.

Note: Because the database profiler can have an impact on the performance, only enable profiling for strategic intervals and as minimally as possible on production systems.

You may enable profiling on a per-`mongod` (page 897) basis. This setting will not propagate across a *replica set* or *sharded cluster*.

The following profiling levels are available:

Level	Setting
0	Off. No profiling.
1	On. Only includes slow operations.
2	On. Includes all operations.

See the output of the profiler in the `system.profile` collection of your database. You can specify the `slowms` (page 950) setting to set a threshold above which the profiler considers operations "slow" and thus included in the level `1` profiling data. You may configure `slowms` (page 950) at runtime, as an argument to the `db.setProfilingLevel()` (page 854) operation.

Additionally, `mongod` (page 897) records all "slow" queries to its `log` (page 946), as defined by `slowms` (page 950). The data in `system.profile` does not persist between `mongod` (page 897) restarts.

You can view the profiler's output by issuing the `show profile` command in the `mongo` (page 908) shell, with the following operation.

```
db.system.profile.find( { millis : { $gt : 100 } } )
```

This returns all operations that lasted longer than 100 milliseconds. Ensure that the value specified here (i.e. `100`) is above the `slowms` (page 950) threshold.

See Also:

Optimization Strategies for MongoDB Applications (page 435) addresses strategies that may improve the performance of your database queries and operations.

8.4 Replication and Monitoring

The primary administrative concern that requires monitoring with replica sets, beyond the requirements for any MongoDB instance, is "replication lag." This refers to the amount of time that it takes a write operation on the *primary* to replicate to a *secondary*. Some very small delay period may be acceptable; however, as replication lag grows, two significant problems emerge:

- First, operations that have occurred in the period of lag are not replicated to one or more secondaries. If you're using replication to ensure data persistence, exceptionally long delays may impact the integrity of your data set.
- Second, if the replication lag exceeds the length of the operation log (*oplog*) then MongoDB will have to perform an initial sync on the secondary, copying all data from the *primary* and rebuilding all indexes. In normal circumstances this is uncommon given the typical size of the oplog, but it's an issue to be aware of.

For causes of replication lag, see *Replication Lag* (page 295).

Replication issues are most often the result of network connectivity issues between members or the result of a *primary* that does not have the resources to support application and replication traffic. To check the status of a replica, use the `replSetGetStatus` (page 788) or the following helper in the shell:

```
rs.status()
```

See the *Replica Set Status Reference* (page 987) document for a more in depth overview view of this output. In general watch the value of `optimeDate` (page 989). Pay particular attention to the difference in time between the *primary* and the *secondary* members.

The size of the operation log is only configurable during the first run using the `--oplogSize` (page 903) argument to the `mongod` (page 897) command, or preferably the `oplogSize` (page 952) in the MongoDB configuration file. If you do not specify this on the command line before running with the `--replSet` (page 903) option, `mongod` (page 897) will create an default sized oplog.

By default the oplog is 5% of total available disk space on 64-bit systems.

See Also:

Change the Size of the Oplog (page 336)

8.5 Sharding and Monitoring

In most cases the components of *sharded clusters* benefit from the same monitoring and analysis as all other MongoDB instances. Additionally, clusters require monitoring to ensure that data is effectively distributed among nodes and that sharding operations are functioning appropriately.

See Also:

See the *Sharding* (page 363) page for more information.

8.5.1 Config Servers

The *config database* provides a map of documents to shards. The cluster updates this map as *chunks* move between shards. When a configuration server becomes inaccessible, some sharding operations like moving chunks and starting `mongos` (page 905) instances become unavailable. However, clusters remain accessible from already-running `mongos` (page 905) instances.

Because inaccessible configuration servers can have a serious impact on the availability of a sharded cluster, you should monitor the configuration servers to ensure that the cluster remains well balanced and that `mongos` (page 905) instances can restart.

8.5.2 Balancing and Chunk Distribution

The most effective *sharded cluster* deployments require that *chunks* are evenly balanced among the shards. MongoDB has a background *balancer* process that distributes data such that chunks are always optimally distributed among the *shards*. Issue the `db.printShardingStatus()` (page 852) or `sh.status()` (page 871) command to the `mongos` (page 905) by way of the `mongo` (page 908) shell. This returns an overview of the entire cluster including the database name, and a list of the chunks.

8.5.3 Stale Locks

In nearly every case, all locks used by the balancer are automatically released when they become stale. However, because any long lasting lock can block future balancing, it's important to insure that all locks are legitimate. To check the lock status of the database, connect to a `mongos` (page 905) instance using the `mongo` (page 908) shell. Issue the following command sequence to switch to the `config` database and display all outstanding locks on the shard database:

```
use config
db.locks.find()
```

For active deployments, the above query might return a useful result set. The balancing process, which originates on a randomly selected `mongos` (page 905), takes a special "balancer" lock that prevents other balancing activity from transpiring. Use the following command, also to the `config` database, to check the status of the "balancer" lock.

```
db.locks.find( { _id : "balancer" } )
```

If this lock exists, make sure that the balancer process is actively using this lock.

CHAPTER 9

Importing and Exporting MongoDB Data

Full *database instance backups* (page 67) are useful for disaster recovery protection and routine database backup operation; however, some cases require additional import and export functionality.

This document provides an overview of the import and export programs included in the MongoDB distribution. These tools are useful when you want to backup or export a portion of your data without capturing the state of the entire database, or for simple data ingestion cases. For more complex data migration tasks, you may want to write your own import and export scripts using a client *driver* to interact with the database itself.

Warning: Because these tools primarily operate by interacting with a running `mongod` (page 897) instance, they can impact the performance of your running database.
Not only do these processes create traffic for a running database instance, they also force the database to read all data through memory. When MongoDB reads infrequently used data, it can supplant more frequently accessed data, causing a deterioration in performance for the database's regular workload.
`mongoimport` (page 925) and `mongoexport` (page 928) do not reliably preserve all rich *BSON* data types, because *BSON* is a superset of *JSON*. Thus, `mongoimport` (page 925) and `mongoexport` (page 928) cannot represent *BSON* data accurately in *JSON*. As a result data exported or imported with these tools may lose some measure of fidelity. See *MongoDB Extended JSON* (page 1024) for more information about MongoDB Extended JSON.

See Also:

See the "*Backup Strategies for MongoDB Systems* (page 67)" document for more information on backing up MongoDB instances. Additionally, consider the following references for commands addressed in this document:

- *mongoexport* (page 928)
- *mongorestore* (page 917)
- *mongodump* (page 914)

If you want to transform and process data once you've imported it in MongoDB consider the topics in *Aggregation* (page 193), including:

- *Map-Reduce* (page 223) and
- *Aggregation Framework* (page 195).

9.1 Data Type Fidelity

JSON does not have the following data types that exist in *BSON* documents: `data_binary`, `data_date`, `data_timestamp`, `data_regex`, `data_oid` and `data_ref`. As a result using any tool that decodes BSON *documents* into JSON will suffer some loss of fidelity.

If maintaining type fidelity is important, consider writing a data import and export system that does not force BSON documents into JSON form as part of the process. The following list of types contain examples for how MongoDB will represent how BSON documents render in JSON.

- `data_binary`

  ```
  { "$binary" : "<bindata>", "$type" : "<t>" }
  ```

  `<bindata>` is the base64 representation of a binary string. `<t>` is the hexadecimal representation of a single byte indicating the data type.

- `data_date`

  ```
  Date( <date> )
  ```

  `<date>` is the JSON representation of a 64-bit signed integer for milliseconds since epoch.

- `data_timestamp`

  ```
  Timestamp( <t>, <i> )
  ```

  `<t>` is the JSON representation of a 32-bit unsigned integer for milliseconds since epoch. `<i>` is a 32-bit unsigned integer for the increment.

- `data_regex`

  ```
  /<jRegex>/<jOptions>
  ```

  `<jRegex>` is a string that may contain valid JSON characters and unescaped double quote (i.e. `"`) characters, but may not contain unescaped forward slash (i.e. `http://docs.mongodb.org/v2.2/`) characters. `<jOptions>` is a string that may contain only the characters `g`, `i`, `m`, and `s`.

- `data_oid`

  ```
  ObjectId( "<id>" )
  ```

  `<id>` is a 24 character hexadecimal string. These representations require that `data_oid` values have an associated field named "*_id*."

- `data_ref`

  ```
  DBRef( "<name>", "<id>" )
  ```

  `<name>` is a string of valid JSON characters. `<id>` is a 24 character hexadecimal string.

See Also:

MongoDB Extended JSON (page 1024)

9.2 Data Import and Export and Backups Operations

For resilient and non-disruptive backups, use a file system or block-level disk snapshot function, such as the methods described in the "*Backup Strategies for MongoDB Systems* (page 67)" document. The tools and operations discussed provide functionality that's useful in the context of providing some kinds of backups.

By contrast, use import and export tools to backup a small subset of your data or to move data to or from a 3rd party system. These backups may capture a small crucial set of data or a frequently modified section of data, for extra insurance, or for ease of access. No matter how you decide to import or export your data, consider the following guidelines:

- Label files so that you can identify what point in time the export or backup reflects.
- Labeling should describe the contents of the backup, and reflect the subset of the data corpus, captured in the backup or export.
- Do not create or apply exports if the backup process itself will have an adverse effect on a production system.
- Make sure that they reflect a consistent data state. Export or backup processes can impact data integrity (i.e. type fidelity) and consistency if updates continue during the backup process.
- Test backups and exports by restoring and importing to ensure that the backups are useful.

9.3 Human Intelligible Import/Export Formats

This section describes a process to import/export your database, or a portion thereof, to a file in a *JSON* or *CSV* format.

See Also:

The *mongoimport* (page 925) and *mongoexport* (page 928) documents contain complete documentation of these tools. If you have questions about the function and parameters of these tools not covered here, please refer to these documents.

If you want to simply copy a database or collection from one instance to another, consider using the `copydb` (page 749), `clone` (page 743), or `cloneCollection` (page 743) commands, which may be more suited to this task. The `mongo` (page 908) shell provides the `db.copyDatabase()` (page 844) method.

These tools may also be useful for importing data into a MongoDB database from third party applications.

9.3.1 Collection Export with `mongoexport`

With the `mongoexport` (page 928) utility you can create a backup file. In the most simple invocation, the command takes the following form:

```
mongoexport --collection collection --out collection.json
```

This will export all documents in the collection named `collection` into the file `collection.json`. Without the output specification (i.e. "*--out collection.json* (page 930)",) `mongoexport` (page 928) writes output to standard output (i.e. "stdout.") You can further narrow the results by supplying a query filter using the "*--query* (page 929)" and limit results to a single database using the "*--db* (page 929)" option. For instance:

```
mongoexport --db sales --collection contacts --query '{"field": 1}'
```

This command returns all documents in the `sales` database's `contacts` collection, with a field named `field` with a value of `1`. Enclose the query in single quotes (e.g. `'`) to ensure that it does not interact with your shell environment. The resulting documents will return on standard output.

By default, `mongoexport` (page 928) returns one *JSON document* per MongoDB document. Specify the "*--jsonArray* (page 929)" argument to return the export as a single *JSON* array. Use the "*--csv* (page 929)" file to return the result in CSV (comma separated values) format.

If your `mongod` (page 897) instance is not running, you can use the "*--dbpath* (page 929)" option to specify the location to your MongoDB instance's database files. See the following example:

```
mongoexport --db sales --collection contacts --dbpath /srv/MongoDB/
```

This reads the data files directly. This locks the data directory to prevent conflicting writes. The mongod (page 897) process must *not* be running or attached to these data files when you run mongoexport (page 928) in this configuration.

The "*--host* (page 928)" and "*--port* (page 928)" options allow you to specify a non-local host to connect to capture the export. Consider the following example:

```
mongoexport --host mongodb1.example.net --port 37017 --username user --password pass --collection co
```

On any mongoexport (page 928) command you may, as above specify username and password credentials as above.

9.3.2 Collection Import with mongoimport

To restore a backup taken with mongoexport (page 928). Most of the arguments to mongoexport (page 928) also exist for mongoimport (page 925). Consider the following command:

```
mongoimport --collection collection --file collection.json
```

This imports the contents of the file collection.json into the collection named collection. If you do not specify a file with the "*--file* (page 926)" option, mongoimport (page 925) accepts input over standard input (e.g. "stdin.")

If you specify the "*--upsert* (page 927)" option, all of mongoimport (page 925) operations will attempt to update existing documents in the database and insert other documents. This option will cause some performance impact depending on your configuration.

You can specify the database option *--db* (page 926) to import these documents to a particular database. If your MongoDB instance is not running, use the "*--dbpath* (page 926)" option to specify the location of your MongoDB instance's database files. Consider using the "*--journal* (page 926)" option to ensure that mongoimport (page 925) records its operations in the journal. The mongod process must *not* be running or attached to these data files when you run mongoimport (page 925) in this configuration.

Use the "*--ignoreBlanks* (page 926)" option to ignore blank fields. For *CSV* and *TSV* imports, this option provides the desired functionality in most cases: it avoids inserting blank fields in MongoDB documents.

CHAPTER 10

Backup Strategies for MongoDB Systems

Backups are an important part of any operational disaster recovery plan. A good backup plan must be able to capture data in a consistent and usable state, and operators must be able to automate both the backup and the recovery operations. Also test all components of the backup system to ensure that you can recover backed up data as needed. If you cannot effectively restore your database from the backup, then your backups are useless. This document addresses higher level backup strategies, for more information on specific backup procedures consider the following documents:

- *Use Filesystem Snapshots to Backup and Restore MongoDB Databases* (page 612).
- *Use mongodump and mongorestore to Backup and Restore MongoDB Databases* (page 609).
- *Backup a Small Sharded Cluster with mongodump* (page 403)
- *Create Backup of a Sharded Cluster with Filesystem Snapshots* (page 403)
- *Create Backup of a Sharded Cluster with Database Dumps* (page 405)
- *Schedule Backup Window for Sharded Clusters* (page 407)
- *Restore a Single Shard* (page 406)
- *Restore Sharded Clusters* (page 407)

10.1 Backup Considerations

As you develop a backup strategy for your MongoDB deployment consider the following factors:

- Geography. Ensure that you move some backups away from the your primary database infrastructure.
- System errors. Ensure that your backups can survive situations where hardware failures or disk errors impact the integrity or availability of your backups.
- Production constraints. Backup operations themselves sometimes require substantial system resources. It is important to consider the time of the backup schedule relative to peak usage and maintenance windows.
- System capabilities. Some of the block-level snapshot tools require special support on the operating-system or infrastructure level.
- Database configuration. *Replication* and *sharding* can affect the process and impact of the backup implementation. See *Sharded Cluster Backup Considerations* (page 68) and *Replica Set Backup Considerations* (page 69).

- Actual requirements. You may be able to save time, effort, and space by including only crucial data in the most frequent backups and backing up less crucial data less frequently.

10.2 Approaches to Backing Up MongoDB Systems

There are two main methodologies for backing up MongoDB instances. Creating binary "dumps" of the database using `mongodump` (page 915) or creating filesystem level snapshots. Both methodologies have advantages and disadvantages:

- binary database dumps are comparatively small, because they don't include index content or pre-allocated free space, and *record padding* (page 127). However, it's impossible to capture a copy of a running system that reflects a single moment in time using a binary dump.
- filesystem snapshots, sometimes called block level backups, produce larger backup sizes, but complete quickly and can reflect a single moment in time on a running system. However, snapshot systems require filesystem and operating system support and tools.

The best option depends on the requirements of your deployment and disaster recovery needs. Typically, filesystem snapshots are because of their accuracy and simplicity; however, `mongodump` (page 915) is a viable option used often to generate backups of MongoDB systems.

The following topics provide details and procedures on the two approaches:

- *Use Filesystem Snapshots to Backup and Restore MongoDB Databases* (page 612).
- *Use mongodump and mongorestore to Backup and Restore MongoDB Databases* (page 609).

In some cases, taking backups is difficult or impossible because of large data volumes, distributed architectures, and data transmission speeds. In these situations, increase the number of members in your replica set or sets.

10.3 Backup Strategies for MongoDB Deployments

10.3.1 Sharded Cluster Backup Considerations

Important: To capture a point-in-time backup from a sharded cluster you **must** stop *all* writes to the cluster. On a running production system, you can only capture an *approximation* of point-in-time snapshot.

Sharded clusters complicate backup operations, as distributed systems. True point-in-time backups are only possible when stopping all write activity from the application. To create a precise moment-in-time snapshot of a cluster, stop all application write activity to the database, capture a backup, and allow only write operations to the database after the backup is complete.

However, you can capture a backup of a cluster that **approximates** a point-in-time backup by capturing a backup from a secondary member of the replica sets that provide the shards in the cluster at roughly the same moment. If you decide to use an approximate-point-in-time backup method, ensure that your application can operate using a copy of the data that does not reflect a single moment in time.

The following documents describe sharded cluster related backup procedures:

- *Backup a Small Sharded Cluster with mongodump* (page 403)
- *Create Backup of a Sharded Cluster with Filesystem Snapshots* (page 403)
- *Create Backup of a Sharded Cluster with Database Dumps* (page 405)
- *Schedule Backup Window for Sharded Clusters* (page 407)

- *Restore a Single Shard* (page 406)
- *Restore Sharded Clusters* (page 407)

10.3.2 Replica Set Backup Considerations

In most cases, backing up data stored in a *replica set* is similar to backing up data stored in a single instance. It is possible to lock a single *secondary* database and then create a backup from that instance. When you unlock the database, the secondary will catch up with the *primary*. You may also choose to deploy a dedicated *hidden member* for backup purposes.

If you have a *sharded cluster* where each *shard* is itself a replica set, you can use this method to create a backup of the entire cluster without disrupting the operation of the node. In these situations you should still turn off the balancer when you create backups.

For any cluster, using a non-primary node to create backups is particularly advantageous in that the backup operation does not affect the performance of the primary. Replication itself provides some measure of redundancy. Nevertheless, keeping point-in time backups of your cluster to provide for disaster recovery and as an additional layer of protection is crucial.

CHAPTER 11

Linux `ulimit` Settings

The Linux kernel provides a system to limit and control the number of threads, connections, and open files on a per-process and per-user basis. These limits prevent single users from using too many system resources. Sometimes, these limits, as configured by the distribution developers, are too low for MongoDB and can cause a number of issues in the course of normal MongoDB operation. Generally, MongoDB should be the only user process on a system, to prevent resource contention.

11.1 Resource Utilization

`mongod` (page 897) and `mongos` (page 905) each use threads and file descriptors to track connections and manage internal operations. This section outlines the general resource utilization patterns for MongoDB. Use these figures in combination with the actual information about your deployment and its use to determine ideal `ulimit` settings.

Generally, all `mongod` (page 897) and `mongos` (page 905) instances, like other processes:

- track each incoming connection with a file descriptor *and* a thread.
- track each internal thread or *pthread* as a system process.

11.1.1 `mongod`

- 1 file descriptor for each data file in use by the `mongod` (page 897) instance.
- 1 file descriptor for each journal file used by the `mongod` (page 897) instance when `journal` (page 948) is `true`.
- In replica sets, each `mongod` (page 897) maintains a connection to all other members of the set.

`mongod` (page 897) uses background threads for a number of internal processes, including *TTL collections* (page 458), replication, and replica set health checks, which may require a small number of additional resources.

11.1.2 `mongos`

In addition to the threads and file descriptors for client connections, `mongos` (page 905) must maintain connects to all config servers and all shards, which includes all members of all replica sets.

For `mongos` (page 905), consider the following behaviors:

- mongos (page 905) instances maintain a connection pool to each shard so that the mongos (page 905) can reuse connections and quickly fulfill requests without needing to create new connections.
- You can limit the number of incoming connections using the maxConns (page 946) run-time option:

  :option:`--maxConns <mongos --maxConns>`

  By restricting the number of incoming connections you can prevent a cascade effect where the mongos (page 905) creates too many connections on the mongod (page 897) instances.

Note: You cannot set maxConns (page 946) to a value higher than *20000*.

11.2 Review and Set Resource Limits

11.2.1 ulimit

You can use the ulimit command at the system prompt to check system limits, as in the following example:

```
$ ulimit -a
-t: cpu time (seconds)         unlimited
-f: file size (blocks)         unlimited
-d: data seg size (kbytes)     unlimited
-s: stack size (kbytes)        8192
-c: core file size (blocks)    0
-m: resident set size (kbytes) unlimited
-u: processes                  192276
-n: file descriptors           21000
-l: locked-in-memory size (kb) 40000
-v: address space (kb)         unlimited
-x: file locks                 unlimited
-i: pending signals            192276
-q: bytes in POSIX msg queues  819200
-e: max nice                   30
-r: max rt priority            65
-N 15:                         unlimited
```

ulimit refers to the per-*user* limitations for various resources. Therefore, if your mongod (page 897) instance executes as a user that is also running multiple processes, or multiple mongod (page 897) processes, you might see contention for these resources. Also, be aware that the processes value (i.e. -u) refers to the combined number of distinct processes and sub-process threads.

You can change ulimit settings by issuing a command in the following form:

```
ulimit -n <value>
```

For many distributions of Linux you can change values by substituting the -n option for any possible value in the output of ulimit -a. See your operating system documentation for the precise procedure for changing system limits on running systems.

Note: After changing the ulimit settings, you *must* restart the process to take advantage of the modified settings. You can use the http://docs.mongodb.org/v2.2/proc file system to see the current limitations on a running process.

Depending on your system's configuration, and default settings, any change to system limits made using ulimit may revert following system a system restart. Check your distribution and operating system documentation for more information.

11.2.2 `/proc` File System

Note: This section applies only to Linux operating systems.

The `http://docs.mongodb.org/v2.2/proc` file-system stores the per-process limits in the file system object located at `http://docs.mongodb.org/v2.2/proc/<pid>/limits`, where `<pid>` is the process's *PID* or process identifier. You can use the following `bash` function to return the content of the `limits` object for a process or processes with a given name:

```
return-limits(){

     for process in $@; do
          process_pids=`ps -C $process -o pid --no-headers | cut -d " " -f 2`

          if [ -z $@ ]; then
             echo "[no $process running]"
          else
             for pid in $process_pids; do
                   echo "[$process #$pid -- limits]"
                   cat /proc/$pid/limits
             done
          fi

     done

}
```

You can copy and paste this function into a current shell session or load it as part of a script. Call the function with one the following invocations:

```
return-limits mongod
return-limits mongos
return-limits mongod mongos
```

The output of the first command may resemble the following:

```
[mongod #6809 -- limits]
Limit                     Soft Limit           Hard Limit           Units
Max cpu time              unlimited            unlimited            seconds
Max file size             unlimited            unlimited            bytes
Max data size             unlimited            unlimited            bytes
Max stack size            8720000              unlimited            bytes
Max core file size        0                    unlimited            bytes
Max resident set          unlimited            unlimited            bytes
Max processes             192276               192276               processes
Max open files            1024                 4096                 files
Max locked memory         40960000             40960000             bytes
Max address space         unlimited            unlimited            bytes
Max file locks            unlimited            unlimited            locks
Max pending signals       192276               192276               signals
Max msgqueue size         819200               819200               bytes
Max nice priority         30                   30
Max realtime priority     65                   65
Max realtime timeout      unlimited            unlimited            us
```

11.3 Recommended Settings

Every deployment may have unique requirements and settings; however, the following thresholds and settings are particularly important for `mongod` (page 897) and `mongos` (page 905) deployments:

- `-f` (file size): `unlimited`
- `-t` (cpu time): `unlimited`
- `-v` (virtual memory): `unlimited`
- `-n` (open files): `64000`
- `-m` (memory size): `unlimited` [1]
- `-u` (processes/threads): `32000`

Always remember to restart your `mongod` (page 897) and `mongos` (page 905) instances after changing the `ulimit` settings to make sure that the settings change takes effect.

[1] If you limit the resident memory size on a system running MongoDB you risk allowing the operating system to terminate the `mongod` (page 897) process under normal situations. Do not set this value. If the operating system (i.e. Linux) kills your `mongod` (page 897), with the OOM killer, check the output of `serverStatus` (page 792) and ensure MongoDB is not leaking memory.

CHAPTER 12

Production Notes

12.1 Overview

This page details system configurations that affect MongoDB, especially in production.

12.2 Backups

To make backups of your MongoDB database, please refer to *Backup Strategies for MongoDB Systems* (page 67).

12.3 Networking

Always run MongoDB in a *trusted environment*, with network rules that prevent access from *all* unknown machines, systems, or networks. As with any sensitive system dependent on network access, your MongoDB deployment should only be accessible to specific systems that require access: application servers, monitoring services, and other MongoDB components.

See documents in the *Security* (page 85) section for additional information, specifically:

- *Interfaces and Port Numbers* (page 88)
- *Firewalls* (page 89)
- *Configure Linux iptables Firewall for MongoDB* (page 95)
- *Configure Windows netsh Firewall for MongoDB* (page 99)

12.4 MongoDB on Linux

If you use the Linux kernel, the MongoDB user community has recommended Linux kernel 2.6.36 or later for running MongoDB in production.

Because MongoDB preallocates its database files before using them and because MongoDB uses very large files on average, you should use the Ext4 and XFS file systems if using the Linux kernel:

- If you use the Ext4 file system, use at least version 2.6.23 of the Linux Kernel.

- If you use the XFS file system, use at least version 2.6.25 of the Linux Kernel.

For MongoDB on Linux use the following recommended configurations:

- Turn off `atime` for the storage volume with the *database files*.
- Set the file descriptor limit and the user process limit above 20,000, according to the suggestions in *Linux ulimit Settings* (page 71). A low ulimit will affect MongoDB when under heavy use and will produce weird errors.
- Do not use `hugepages` virtual memory pages, MongoDB performs better with normal virtual memory pages.
- Disable NUMA in your BIOS. If that is not possible see *NUMA* (page 77).
- Ensure that readahead settings for the block devices that store the database files are acceptable. See the *Readahead* (page 76) section
- Use NTP to synchronize time among your hosts. This is especially important in sharded clusters.

12.5 Readahead

For random access use patterns set readahead values low, for example setting readahead to a small value such as 32 (16KB) often works well.

12.6 MongoDB on Virtual Environments

The section describes considerations when running MongoDB in some of the more common virtual environments.

12.6.1 EC2

MongoDB is compatible with EC2 and requires no configuration changes specific to the environment.

12.6.2 VMWare

MongoDB is compatible with VMWare. Some in the MongoDB community have run into issues with VMWare's memory overcommit feature and suggest disabling the feature.

You can clone a virtual machine running MongoDB. You might use this to spin up a new virtual host that will be added as a member of a replica set. If journaling is enabled, the clone snapshot will be consistent. If not using journaling, stop `mongod` (page 897), clone, and then restart.

12.6.3 OpenVZ

The MongoDB community has encountered issues running MongoDB on OpenVZ.

12.7 Disk and Storage Systems

12.7.1 Swap

Configure swap space for your systems. Having swap can prevent issues with memory contention and can prevent the OOM Killer on Linux systems from killing `mongod` (page 897). Because of the way `mongod` (page 897) maps

memory files to memory, the operating system will never store MongoDB data in swap.

12.7.2 RAID

Most MongoDB deployments should use disks backed by RAID-10.

RAID-5 and RAID-6 do not typically provide sufficient performance to support a MongoDB deployment.

RAID-0 provides good write performance but provides limited availability, and reduced performance on read operations, particularly using Amazon's EBS volumes: as a result, avoid RAID-0 with MongoDB deployments.

12.7.3 Remote Filesystems

Some versions of NFS perform very poorly with MongoDB and NFS is not recommended for use with MongoDB. Performance problems arise when both the data files and the journal files are both hosted on NFS: you may experience better performance if you place the journal on local or `iscsi` volumes. If you must use NFS, add the following NFS options to your `http://docs.mongodb.org/v2.2/etc/fstab` file: `bg`, `nolock`, and `noatime`.

Many MongoDB deployments work successfully with Amazon's *Elastic Block Store* (EBS) volumes. There are certain intrinsic performance characteristics, with EBS volumes that users should consider.

12.8 Hardware Requirements and Limitations

MongoDB is designed specifically with commodity hardware in mind and has few hardware requirements or limitations. MongoDB core components runs on little-endian hardware primarily x86/x86_64 processors. Client libraries (i.e. drivers) can run on big or little endian systems.

When installing hardware for MongoDB, consider the following:

- As with all software, more RAM and a faster CPU clock speed are important to productivity.
- Because databases do not perform high amounts of computation, increasing the number cores helps but does not provide a high level of marginal return.
- MongoDB has good results and good price/performance with SATA SSD (Solid State Disk) and with PCI (Peripheral Component Interconnect).
- Commodity (SATA) spinning drives are often a good option as the speed increase for random I/O for more expensive drives is not that dramatic (only on the order of 2x), spending that money on SSDs or RAM may be more effective.

12.8.1 MongoDB on NUMA Hardware

MongoDB and NUMA, Non-Uniform Access Memory, do not work well together. When running MongoDB on NUMA hardware, disable NUMA for MongoDB and run with an interleave memory policy. NUMA can cause a number of operational problems with MongoDB, including slow performance for periods of time or high system processor usage.

Note: On Linux, MongoDB version 2.0 and greater checks these settings on start up and prints a warning if the system is NUMA-based.

To disable NUMA for MongoDB, use the `numactl` command and start `mongod` (page 897) in the following manner:

```
numactl --interleave=all /usr/bin/local/mongod
```

Adjust the `proc` settings using the following command:

```
echo 0 > /proc/sys/vm/zone_reclaim_mode
```

To fully disable NUMA you must perform both operations. However, you can change `zone_reclaim_mode` without restarting mongod. For more information, see documentation on Proc/sys/vm.

See the The MySQL "swap insanity" problem and the effects of NUMA post, which describes the effects of NUMA on databases. This blog post addresses the impact of NUMA for MySQL; however, the issues for MongoDB are similar. The post introduces NUMA its goals, and illustrates how these goals are not compatible with production databases.

12.9 Performance Monitoring

12.9.1 iostat

On Linux, use the iostat command to check if disk I/O is a bottleneck for your database. Specify a number of seconds when running iostat to avoid displaying stats covering the time since server boot.

For example:

```
iostat -xm 2
```

Use the mount command to see what device your `data directory` (page 947) resides on.

Key fields from `iostat`:

- `%util`: this is the most useful field for a quick check, it indicates what percent of the time the device/drive is in use.
- `avgrq-sz`: average request size. Smaller number for this value reflect more random IO operations.

12.9.2 bwm-ng

bwm-ng is a command-line tool for monitoring network use. If you suspect a network-based bottleneck, you may use `bwm-ng` to begin your diagnostic process.

12.10 Production Checklist

12.10.1 64-bit Builds for Production

Always use 64-bit Builds for Production. MongoDB uses memory mapped files. See the *32-bit limitations* (page 638) for more information.

32-bit builds exist to support use on development machines and also for other miscellaneous things such as replica set arbiters.

12.10.2 BSON Document Size Limit

There is a `BSON Document Size` (page 1021) – at the time of this writing 16MB per document. If you have large objects, use *GridFS* (page 146) instead.

12.10.3 Set Appropriate Write Concern for Write Operations

See *write concern* (page 124) for more information.

12.10.4 Dynamic Schema

Data in MongoDB has a *dynamic schema*. *Collections* do not enforce *document* structure. This facilitates iterative development and polymorphism. However, collections often hold documents with highly homogeneous structures. See *Data Modeling Considerations for MongoDB Applications* (page 131) for more information.

Some operational considerations include:

- the exact set of collections to be used
- the indexes to be used, which are created explicitly except for the `_id` index
- shard key declarations, which are explicit and quite important as it is hard to change shard keys later

One very simple rule-of-thumb is not to import data from a relational database unmodified: you will generally want to "roll up" certain data into richer documents that use some embedding of nested documents and arrays (and/or arrays of subdocuments).

12.10.5 Updates by Default Affect Only one Document

Set the `multi` parameter to `true` to `update` (page 842) multiple documents that meet the query criteria. The `mongo` (page 908) shell syntax is:

```
db.my_collection_name.update(my_query, my_update_expression, bool_upsert, bool_multi)
```

Set `bool_multi` to `true` when updating many documents. Otherwise only the first matched will update.

12.10.6 Case Sensitive Strings

MongoDB strings are case sensitive. So a search for `"joe"` will not find `"Joe"`.

Consider:

- storing data in a normalized case format, or
- using regular expressions ending with `http://docs.mongodb.org/v2.2/i`
- and/or using *$toLower* (page 737) or *$toUpper* (page 737) in the *aggregation framework* (page 195)

12.10.7 Type Sensitive Fields

MongoDB data – which is JSON-style, specifically, BSON format – have several data types.

Consider the following document which has a field `x` with the *string* value `"123"`:

```
{ x : "123" }
```

Then the following query which looks for a *number* value `123` will **not** return that document:

```
db.mycollection.find( { x : 123 } )
```

12.10.8 Locking

Older versions of MongoDB used a "global lock"; use MongoDB v2.2+ for better results. See the *Concurrency* (page 653) page for more information.

12.10.9 Packages

Be sure you have the latest stable release if you are using a package manager. You can see what is current on the Downloads page, even if you then choose to install via a package manager.

12.10.10 Use Odd Number of Replica Set Members

Replica sets (page 277) perform consensus elections. Use either an odd number of members (e.g., three) or else use an arbiter to get up to an odd number of votes.

12.10.11 Don't disable journaling

See *Journaling* (page 41) for more information.

12.10.12 Keep Replica Set Members Up-to-Date

This is important as MongoDB replica sets support automatic failover. Thus you want your secondaries to be up-to-date. You have a few options here:

1. Monitoring and alerts for any lagging can be done via various means. MMS shows a graph of replica set lag
2. Using *getLastError* (page 303) with `w:'majority'`, you will get a timeout or no return if a majority of the set is lagging. This is thus another way to guard against lag and get some reporting back of its occurrence.
3. Or, if you want to fail over manually, you can set your secondaries to `priority:0` in their configuration. Then manual action would be required for a failover. This is practical for a small cluster; for a large cluster you will want automation.

Additionally, see information on *replica set rollbacks* (page 281).

12.10.13 Additional Deployment Considerations

- Pick your shard keys carefully! There is no way to modify a shard key on a collection that is already sharded.
- You cannot shard an existing collection over 256 gigabytes. To shard large amounts of data, create a new empty sharded collection, and ingest the data from the source collection using an application level import operation.
- Unique indexes are not enforced across shards except for the shard key itself. See *Enforce Unique Keys for Sharded Collections* (page 410).
- Consider *pre-splitting* (page 368) a sharded collection before a massive bulk import. Usually this isn't necessary but on a bulk import of size it is helpful.
- Use *security/auth* (page 87) mode if you need it. By default `auth` (page 947) is not enabled and `mongod` (page 897) assumes a trusted environment.
- You do not have *fully generalized transactions* (page 453). Create rich documents and read the preceding link and consider the use case – often there is a good fit.

- Disable NUMA for best results. If you have NUMA enabled, `mongod` (page 897) will print a warning when it starts.
- Avoid excessive prefetch/readahead on the filesystem. Check your prefetch settings. Note on linux the parameter is in *sectors*, not bytes. 32KBytes (a setting of 64 sectors) is pretty reasonable.
- Check *ulimits* (page 71) settings.
- Use SSD if available and economical. Spinning disks can work well but SSDs capacity for random I/O operations work well with the update model of `mongod` (page 897). See *Remote Filesystems* (page 77) for more info.
- Ensure that clients keep reasonable pool sizes to avoid overloading the connection tracking capacity of a single `mongod` (page 897) or `mongos` (page 905) instance.

See Also:

- *Replica Set Operation and Management* (page 285)
- *Replica Set Architectures and Deployment Patterns* (page 300)
- *Sharded Cluster Administration* (page 368)
- *Sharded Cluster Architectures* (page 372)
- *Tag Aware Sharding* (page 408)
- *Indexing Overview* (page 241)
- *Indexing Operations* (page 251)

Additionally, Consider the *MongoDB Tutorials* (page 591) page that contains a full index of all tutorials available in the MongoDB manual. These documents provide pragmatic instructions for common operational practices and administrative tasks.

Part III

Security

The documents outline basic security practices and risk management strategies. Additionally, this section includes *MongoDB Tutorials* (page 591) that outline basic network filter and firewall rules to configure trusted environments for MongoDB.

CHAPTER 13

Strategies and Practices

13.1 Security Practices and Management

As with all software running in a networked environment, administrators of MongoDB must consider security and risk exposures for a MongoDB deployment. There are no magic solutions for risk mitigation, and maintaining a secure MongoDB deployment is an ongoing process. This document takes a *Defense in Depth* approach to securing MongoDB deployments, and addresses a number of different methods for managing risk and reducing risk exposure

The intent of *Defense In Depth* approaches are to ensure there are no exploitable points of failure in your deployment that could allow an intruder or un-trusted party to access the data stored in the MongoDB database. The easiest and most effective way to reduce the risk of exploitation is to run MongoDB in a trusted environment, limit access, follow a system of least privilege, and follow best development and deployment practices. See the *Strategies for Reducing Risk* (page 87) section for more information.

13.1.1 Strategies for Reducing Risk

The most effective way to reduce risk for MongoDB deployments is to run your entire MongoDB deployment, including all MongoDB components (i.e. `mongod` (page 897), `mongos` (page 905) and application instances) in a *trusted environment*. Trusted environments use the following strategies to control access:

- network filter (e.g. firewall) rules that block all connections from unknown systems to MongoDB components.
- bind `mongod` (page 897) and `mongos` (page 905) instances to specific IP addresses to limit accessibility.
- limit MongoDB programs to non-public local networks, and virtual private networks.

You may further reduce risk by:

- requiring authentication for access to MongoDB instances.
- requiring strong, complex, single purpose authentication credentials. This should be part of your internal security policy but is not currently configurable in MongoDB.
- deploying a model of least privilege, where all users have *only* the amount of access they need to accomplish required tasks, and no more.
- following the best application development and deployment practices, which includes: validating all inputs, managing sessions, and application-level access control.

Continue reading this document for more information on specific strategies and configurations to help reduce the risk exposure of your application.

13.1.2 Vulnerability Notification

10gen takes the security of MongoDB and associated products very seriously. If you discover a vulnerability in MongoDB or another 10gen product, or would like to know more about our vulnerability reporting and response process, see the *Vulnerability Notification* (page 92) document.

13.1.3 Networking Risk Exposure

Interfaces and Port Numbers

The following list includes all default ports used by MongoDB:

By default, listens for connections on the following ports:

27017 This is the default port `mongod` (page 897) and `mongos` (page 905) instances. You can change this port with `port` (page 945) or `--port` (page 898).

27018 This is the default port when running with `--shardsvr` (page 904) runtime operation or `shardsvr` (page 953) setting.

27019 This is the default port when running with `--configsvr` (page 904) runtime operation or `configsvr` (page 953) setting.

28017 This is the default port for the web status page. This is always accessible at a port that is `1000` greater than the port determined by `port` (page 945).

By default MongoDB programs (i.e. `mongos` (page 905) and `mongod` (page 897)) will bind to all available network interfaces (i.e. IP addresses) on a system. The next section outlines various runtime options that allow you to limit access to MongoDB programs.

Network Interface Limitation

You can limit the network exposure with the following configuration options:

- the `nohttpinterface` (page 949) setting for `mongod` (page 897) and `mongos` (page 905) instances.

  Disables the "home" status page, which would run on port `28017` by default. The status interface is read-only by default. You may also specify this option on the command line as `mongod --nohttpinterface` (page 900) or `mongos --nohttpinterface` (page 907). Authentication does not control or affect access to this interface.

  Important: Disable this option for production deployments. If *do* you leave this interface enabled, you should only allow trusted clients to access this port.

- the `port` (page 945) setting for `mongod` (page 897) and `mongos` (page 905) instances.

  Changes the main port on which the `mongod` (page 897) or `mongos` (page 905) instance listens for connections. Changing the port does not meaningfully reduce risk or limit exposure.

  You may also specify this option on the command line as `mongod --port` (page 898) or `mongos --port` (page 905).

  Whatever port you attach `mongod` (page 897) and `mongos` (page 905) instances to, you should only allow trusted clients to connect to this port.

- the `rest` (page 950) setting for `mongod` (page 897).

  Enables a fully interactive administrative *REST* interface, which is *disabled by default.* The status interface, which *is* enabled by default, is read-only. This configuration makes that interface fully interactive. The REST interface does not support any authentication and you should always restrict access to this interface to only allow trusted clients to connect to this port.

  You may also enable this interface on the command line as *`mongod --rest`* (page 901).

  Important: Disable this option for production deployments. If *do* you leave this interface enabled, you should only allow trusted clients to access this port.

- the `bind_ip` (page 945) setting for `mongod` (page 897) and `mongos` (page 905) instances.

  Limits the network interfaces on which MongoDB programs will listen for incoming connections. You can also specify a number of interfaces by passing `bind_ip` (page 945) a comma separated list of IP addresses. You can use the *`mongod --bind_ip`* (page 898) and *`mongos --bind_ip`* (page 905) option on the command line at run time to limit the network accessibility of a MongoDB program.

  Important: Make sure that your `mongod` (page 897) and `mongos` (page 905) instances are only accessible on trusted networks. If your system has more than one network interface, bind MongoDB programs to the private or internal network interface.

Firewalls

Firewalls allow administrators to filter and control access to a system by providing granular control over what network communications. For administrators of MongoDB, the following capabilities are important:

- limiting incoming traffic on a specific port to specific systems.
- limiting incoming traffic from untrusted hosts.

On Linux systems, the `iptables` interface provides access to the underlying `netfilter` firewall. On Windows systems `netsh` command line interface provides access to the underlying Windows Firewall. For additional information about firewall configuration consider the following documents:

- *Configure Linux iptables Firewall for MongoDB* (page 95)
- *Configure Windows netsh Firewall for MongoDB* (page 99)

For best results and to minimize overall exposure, ensure that *only* traffic from trusted sources can reach `mongod` (page 897) and `mongos` (page 905) instances and that the `mongod` (page 897) and `mongos` (page 905) instances can only connect to trusted outputs.

See Also:

For MongoDB deployments on Amazon's web services, see the Amazon EC2 page, which addresses Amazon's Security Groups and other EC2-specific security features.

Virtual Private Networks

Virtual private networks, or VPNs, make it possible to link two networks over an encrypted and limited-access trusted network. Typically MongoDB users who use VPNs use SSL rather than IPSEC VPNs for performance issues.

Depending on configuration and implementation VPNs provide for certificate validation and a choice of encryption protocols, which requires a rigorous level of authentication and identification of all clients. Furthermore, because

VPNs provide a secure tunnel, using a VPN connection to control access to your MongoDB instance, you can prevent tampering and "man-in-the-middle" attacks.

13.1.4 Operations

Always run the `mongod` (page 897) or `mongos` (page 905) process as a *unique* user with the minimum required permissions and access. Never run a MongoDB program as a `root` or administrative users. The system users that run the MongoDB processes should have robust authentication credentials that prevent unauthorized or casual access.

To further limit the environment, you can run the `mongod` (page 897) or `mongos` (page 905) process in a `chroot` environment. Both user-based access restrictions and `chroot` configuration follow recommended conventions for administering all daemon processes on Unix-like systems.

You can disable anonymous access to the database by enabling authentication using the `auth` (page 947) as detailed in the *Authentication* (page 90) section.

13.1.5 Authentication

MongoDB provides basic support for authentication with the `auth` (page 947) setting. For multi-instance deployments (i.e. *replica sets*, and *sharded clusters*) use the `keyFile` (page 947) setting, which implies `auth` (page 947), and allows intra-deployment authentication and operation. Be aware of the following behaviors of MongoDB's authentication system:

- Authentication is **disabled** by default.
- MongoDB provisions access on a per-database level. Users either have *read only* access to a database or *normal* access to a database that permits full read and write access to the database. *Normal* access conveys the ability to add additional users to the database.
- The `system.users` collection in each database stores all credentials. You can query the authorized users with the following operation:

  ```
  db.system.users.find()
  ```

- The `admin` database is unique. Users with *normal* access to the `admin` database have read and write access to all databases. Users with *read only* access to the `admin` database have read only access to all databases, with the exception of the `system.users` collection, which is protected to prevent privilege escalation attacks.

  Additionally the `admin` database exposes several commands and functionality, such as `listDatabases` (page 774).
- Once authenticated a *normal* user has full read and write access to a database.
- If you have authenticated to a database as a normal, read and write, user; authenticating as a read-only user on the same database will invalidate the earlier authentication, leaving the current connection with read only access.
- If you have authenticated to the `admin` database as normal, read and write, user; logging into a *different* database as a read only user will *not* invalidate the authentication to the `admin` database. In this situation, this client will be able to read and write data to this second database.
- When setting up authentication for the first time you must either:

  1. add at least one user to the `admin` database before starting the `mongod` (page 897) instance with `auth` (page 947).

2. add the first user to the `admin` database when connected to the `mongod` (page 897) instance from a `localhost` connection. [1]

New in version 2.0: Support for authentication with sharded clusters. Before 2.0 sharded clusters *had* to run with trusted applications and a trusted networking configuration. Consider the *Control Access to MongoDB Instances with Authentication* (page 102) document which outlines procedures for configuring and maintaining users and access with MongoDB's authentication system.

13.1.6 Interfaces

Simply limiting access to a `mongod` (page 897) is not sufficient for totally controlling risk exposure. Consider the recommendations in the following section, for limiting exposure other interface-related risks.

JavaScript and the Security of the `mongo` Shell

Be aware of the following capabilities and behaviors of the `mongo` (page 908) shell:

- `mongo` (page 908) will evaluate a `.js` file passed to the *`mongo --eval`* (page 909) option. The `mongo` (page 908) shell does not validate the input of JavaScript input to *`--eval`* (page 909).
- `mongo` (page 908) will evaluate a `.mongorc.js` file before starting. You can disable this behavior by passing the *`mongo --norc`* (page 908) option.

  On Linux and Unix systems, `mongo` (page 908) reads the `.mongorc.js` file from *`$HOME`*`/.mongorc.js` (i.e. `~/.mongorc.js`), and Windows `mongo.exe` reads the `.mongorc.js` file from *`%HOME%`*`.mongorc.js` or *`%HOMEDRIVE%%HOMEPATH%`*`.mongorc.js`.

HTTP Status Interface

The HTTP status interface provides a web-based interface that includes a variety of operational data, logs, and status reports regarding the `mongod` (page 897) or `mongos` (page 905) instance. The HTTP interface is always available on the port numbered `1000` greater than the primary `mongod` (page 897) port. By default this is `28017`, but is indirectly set using the `port` (page 945) option which allows you to configure the primary `mongod` (page 897) port.

Without the `rest` (page 950) setting, this interface is entirely read-only, and limited in scope; nevertheless, this interface may represent an exposure. To disable the HTTP interface, set the `nohttpinterface` (page 949) run time option or the *`--nohttpinterface`* (page 900) command line option.

REST API

The REST API to MongoDB provides additional information and write access on top of the HTTP Status interface. The REST interface is *disabled* by default, and is not recommended for production use.

While the REST API does not provide any support for insert, update, or remove operations, it does provide administrative access, and its accessibility represents a vulnerability in a secure environment.

If you must use the REST API, please control and limit access to the REST API. The REST API does not include any support for authentication, even if when running with `auth` (page 947) enabled.

See the following documents for instructions on restricting access to the REST API interface:

- *Configure Linux iptables Firewall for MongoDB* (page 95)

[1] Because of SERVER-6591, you cannot add the first user to a sharded cluster using the `localhost` connection in 2.2. If you are running a 2.2 sharded cluster, and want to enable authentication, you must deploy the cluster and add the first user to the `admin` database before restarting the cluster to run with `keyFile` (page 947).

- *Configure Windows netsh Firewall for MongoDB* (page 99)

13.1.7 Data Encryption

To support audit requirements, you may need to encrypt data stored in MongoDB. For best results you can encrypt this data in the application layer, by encrypting the content of fields that hold secure data.

Additionally, 10gen has a partnership with Gazzang to encrypt and secure sensitive data within MongoDB. The solution encrypts data in real time and Gazzang provides advanced key management that ensures only authorized processes and can access this data. The Gazzang software ensures that the cryptographic keys remain safe and ensures compliance with standards including HIPAA, PCI-DSS, and FERPA. For more information consider the following resources:

- Datasheet
- Webinar

13.2 Vulnerability Notification

10gen values the privacy and security of all users of MongoDB, and we work very hard to ensure that MongoDB and related tools minimize risk exposure and increase the security and integrity of data and environments using MongoDB.

13.2.1 Notification

If you believe you have discovered a vulnerability in MongoDB or a related product or have experienced a security incident related to MongoDB, please report these issues so that 10gen can respond appropriately and work to prevent additional issues in the future. All vulnerability reports should contain as much information as possible so that we can move quickly to resolve the issue. In particular, please include the following:

- The name of the product.
- *Common Vulnerability* information, if applicable, including:
  - CVSS (Common Vulnerability Scoring System) Score.
  - CVE (Common Vulnerability and Exposures) Identifier.
- Contact information, including an email address and/or phone number, if applicable.

10gen will respond to all vulnerability notifications within 48 hours.

Jira

10gen prefers jira.mongodb.org for all communication regarding MongoDB and related products.

Submit a ticket in the Core Server Security" project, at: <https://jira.mongodb.org/browse/SECURITY/>. The ticket number will become reference identification for the issue for the lifetime of the issue, and you can use this identifier for tracking purposes.

10gen will respond to any vulnerability notification received in a Jira case posted to the SECURITY project.

Email

While Jira is the preferred communication vector, you may also report vulnerabilities via email to <security@10gen.com>.

You may encrypt email using our public key, to ensure the privacy of any sensitive information in your vulnerability report.

10gen will respond to any vulnerability notification received via email with email which will contain a reference number (i.e. a ticket from the SECURITY project,) Jira case posted to the SECURITY project.

Evaluation

10gen will validate all submitted vulnerabilities. 10gen will use Jira to track all communications regarding the vulnerability, which may include requests for clarification and for additional information. If needed 10gen representatives can set up a conference call to exchange information regarding the vulnerability.

Disclosure

10gen requests that you do *not* publicly disclose any information regarding the vulnerability or exploit the issue until 10gen has had the opportunity to analyze the vulnerability, respond to the notification, and to notify key users, customers, and partners if needed.

The amount of time required to validate a reported vulnerability depends on the complexity and severity of the issue. 10gen takes all required vulnerabilities very seriously and will always ensure that there is a clear and open channel of communication with the reporter of the vulnerability.

After validating the issue, 10gen will coordinate public disclosure of the issue with the reporter in a mutually agreed timeframe and format. If required or requested, the reporter of a vulnerability will receive credit in the published security bulletin.

CHAPTER 14

Tutorials

14.1 Configure Linux `iptables` Firewall for MongoDB

On contemporary Linux systems, the `iptables` program provides methods for managing the Linux Kernel's `netfilter` or network packet filtering capabilities. These firewall rules make it possible for administrators to control what hosts can connect to the system, and limit risk exposure by limiting the hosts that can connect to a system.

This document outlines basic firewall configurations for `iptables` firewalls on Linux. Use these approaches as a starting point for your larger networking organization. For a detailed over view of security practices and risk management for MongoDB, see *Security Practices and Management* (page 87).

See Also:

For MongoDB deployments on Amazon's web services, see the Amazon EC2 page, which addresses Amazon's Security Groups and other EC2-specific security features.

14.1.1 Overview

Rules in `iptables` configurations fall into chains, which describe the process for filtering and processing specific streams of traffic. Chains have an order, and packets must pass through earlier rules in a chain to reach later rules. This document only the following two chains:

`INPUT` Controls all incoming traffic.

`OUTPUT` Controls all outgoing traffic.

Given the *default ports* (page 88) of all MongoDB processes, you must configure networking rules that permit *only* required communication between your application and the appropriate `mongod` (page 897) and `mongos` (page 905) instances.

Be aware that, by default, the default policy of `iptables` is to allow all connections and traffic unless explicitly disabled. The configuration changes outlined in this document will create rules that explicitly allow traffic from specific addresses and on specific ports, using a default policy that drops all traffic that is not explicitly allowed. When you have properly configured your `iptables` rules to allow only the traffic that you want to permit, you can *Change Default Policy to DROP* (page 98).

14.1.2 Patterns

This section contains a number of patterns and examples for configuring `iptables` for use with MongoDB deployments. If you have configured different ports using the `port` (page 945) configuration setting, you will need to modify the rules accordingly.

Traffic to and from `mongod` Instances

This pattern is applicable to all `mongod` (page 897) instances running as standalone instances or as part of a *replica set*.

The goal of this pattern is to explicitly allow traffic to the `mongod` (page 897) instance from the application server. In the following examples, replace `<ip-address>` with the IP address of the application server:

```
iptables -A INPUT -s <ip-address> -p tcp --destination-port 27017 -m state --state NEW,ESTABLISHED -
iptables -A OUTPUT -d <ip-address> -p tcp --source-port 27017 -m state --state ESTABLISHED -j ACCEPT
```

The first rule allows all incoming traffic from `<ip-address>` on port `27017`, which allows the application server to connect to the `mongod` (page 897) instance. The second rule, allows outgoing traffic from the `mongod` (page 897) to reach the application server.

Optional

If you have only one application server, you can replace `<ip-address>` with either the IP address itself, such as: `198.51.100.55`. You can also express this using CIDR notation as `198.51.100.55/32`. If you want to permit a larger block of possible IP addresses you can allow traffic from a `http://docs.mongodb.org/v2.2/24` using one of the following specifications for the `<ip-address>`, as follows:

```
10.10.10.10/24
10.10.10.10/255.255.255.0
```

Traffic to and from `mongos` Instances

`mongos` (page 905) instances provide query routing for *sharded clusters*. Clients connect to `mongos` (page 905) instances, which behave from the client's perspective as `mongod` (page 897) instances. In turn, the `mongos` (page 905) connects to all `mongod` (page 897) instances that are components of the sharded cluster.

Use the same `iptables` command to allow traffic to and from these instances as you would from the `mongod` (page 897) instances that are members of the replica set. Take the configuration outlined in the *Traffic to and from mongod Instances* (page 96) section as an example.

Traffic to and from a MongoDB Config Server

Config servers, host the *config database* that stores metadata for sharded clusters. Each production cluster has three config servers, initiated using the *`mongod --configsvr`* (page 904) option. [1] Config servers listen for connections on port `27019`. As a result, add the following `iptables` rules to the config server to allow incoming and outgoing connection on port `27019`, for connection to the other config servers.

```
iptables -A INPUT -s <ip-address> -p tcp --destination-port 27019 -m state --state NEW,ESTABLISHED -
iptables -A OUTPUT -d <ip-address> -p tcp --source-port 27019 -m state --state ESTABLISHED -j ACCEPT
```

[1] You can also run a config server by setting the `configsvr` (page 953) option in a configuration file.

Replace <ip-address> with the address or address space of *all* the mongod (page 897) that provide config servers.

Additionally, config servers need to allow incoming connections from all of the mongos (page 905) instances in the cluster *and* all mongod (page 897) instances in the cluster. Add rules that resemble the following:

```
iptables -A INPUT -s <ip-address> -p tcp --destination-port 27019 -m state --state NEW,ESTABLISHED -
```

Replace <ip-address> with the address of the mongos (page 905) instances and the shard mongod (page 897) instances.

Traffic to and from a MongoDB Shard Server

For shard servers, running as *mongod --shardsvr* (page 904) [2] Because the default port number when running with shardsvr (page 953) is 27018, you must configure the following iptables rules to allow traffic to and from each shard:

```
iptables -A INPUT -s <ip-address> -p tcp --destination-port 27018 -m state --state NEW,ESTABLISHED -
iptables -A OUTPUT -d <ip-address> -p tcp --source-port 27018 -m state --state ESTABLISHED -j ACCEPT
```

Replace the <ip-address> specification with the IP address of all mongod (page 897). This allows you to permit incoming and outgoing traffic between all shards including constituent replica set members, to:

- all mongod (page 897) instances in the shard's replica sets.
- all mongod (page 897) instances in other shards. [3]

Furthermore, shards need to be able make outgoing connections to:

- all mongos (page 905) instances.
- all mongod (page 897) instances in the config servers.

Create a rule that resembles the following, and replace the <ip-address> with the address of the config servers and the mongos (page 905) instances:

```
iptables -A OUTPUT -d <ip-address> -p tcp --source-port 27018 -m state --state ESTABLISHED -j ACCEPT
```

Provide Access For Monitoring Systems

1. The mongostat (page 931) diagnostic tool, when running with the *--discover* (page 932) needs to be able to reach all components of a cluster, including the config servers, the shard servers, and the mongos (page 905) instances.
2. If your monitoring system needs access the HTTP interface, insert the following rule to the chain:

   ```
   iptables -A INPUT -s <ip-address> -p tcp --destination-port 28017 -m state --state NEW,ESTABLISH
   ```

   Replace <ip-address> with the address of the instance that needs access to the HTTP or REST interface. For *all* deployments, you should restrict access to this port to *only* the monitoring instance.

   Optional

   For shard server mongod (page 897) instances running with shardsvr (page 953), the rule would resemble the following:

[2] You can also specify the shard server option using the shardsvr (page 953) setting in the configuration file. Shard members are also often conventional replica sets using the default port.

[3] All shards in a cluster need to be able to communicate with all other shards to facilitate *chunk* and balancing operations.

```
iptables -A INPUT -s <ip-address> -p tcp --destination-port 28018 -m state --state NEW,ESTABLISH
```

For config server `mongod` (page 897) instances running with `configsvr` (page 953), the rule would resemble the following:

```
iptables -A INPUT -s <ip-address> -p tcp --destination-port 28019 -m state --state NEW,ESTABLISH
```

14.1.3 Change Default Policy to `DROP`

The default policy for `iptables` chains is to allow all traffic. After completing all `iptables` configuration changes, you *must* change the default policy to `DROP` so that all traffic that isn't explicitly allowed as above will not be able to reach components of the MongoDB deployment. Issue the following commands to change this policy:

```
iptables -P INPUT DROP

iptables -P OUTPUT DROP
```

14.1.4 Manage and Maintain `iptables` Configuration

This section contains a number of basic operations for managing and using `iptables`. There are various front end tools that automate some aspects of `iptables` configuration, but at the core all `iptables` front ends provide the same basic functionality:

Make all `iptables` Rules Persistent

By default all `iptables` rules are only stored in memory. When your system restarts, your firewall rules will revert to their defaults. When you have tested a rule set and have guaranteed that it effectively controls traffic you can use the following operations to you should make the rule set persistent.

On Red Hat Enterprise Linux, Fedora Linux, and related distributions you can issue the following command:

```
service iptables save
```

On Debian, Ubuntu, and related distributions, you can use the following command to dump the `iptables` rules to the `http://docs.mongodb.org/v2.2/etc/iptables.conf` file:

```
iptables-save > /etc/iptables.conf
```

Run the following operation to restore the network rules:

```
iptables-restore < /etc/iptables.conf
```

Place this command in your `rc.local` file, or in the `http://docs.mongodb.org/v2.2/etc/network/if-up.d/iptabl` file with other similar operations.q

List all `iptables` Rules

To list all of currently applied `iptables` rules, use the following operation at the system shell.

```
iptables --L
```

Flush all `iptables` Rules

If you make a configuration mistake when entering `iptables` rules or simply need to revert to the default rule set, you can use the following operation at the system shell to flush all rules:

```
iptables --F
```

If you've already made your `iptables` rules persistent, you will need to repeat the appropriate procedure in the *Make all iptables Rules Persistent* (page 98) section.

14.2 Configure Windows `netsh` Firewall for MongoDB

On Windows Server systems, the `netsh` program provides methods for managing the *Windows Firewall*. These firewall rules make it possible for administrators to control what hosts can connect to the system, and limit risk exposure by limiting the hosts that can connect to a system.

This document outlines basic *Windows Firewall* configurations. Use these approaches as a starting point for your larger networking organization. For a detailed over view of security practices and risk management for MongoDB, see *Security Practices and Management* (page 87).

See Also:

Windows Firewall documentation from Microsoft.

14.2.1 Overview

Windows Firewall processes rules in an ordered determined by rule type, and parsed in the following order:

1. `Windows Service Hardening`
2. `Connection security rules`
3. `Authenticated Bypass Rules`
4. `Block Rules`
5. `Allow Rules`
6. `Default Rules`

By default, the policy in *Windows Firewall* allows all outbound connections and blocks all incoming connections.

Given the *default ports* (page 88) of all MongoDB processes, you must configure networking rules that permit *only* required communication between your application and the appropriate `mongod.exe` (page 912) and `mongos.exe` (page 913) instances.

The configuration changes outlined in this document will create rules which explicitly allow traffic from specific addresses and on specific ports, using a default policy that drops all traffic that is not explicitly allowed.

You can configure the *Windows Firewall* with using the `netsh` command line tool or through a windows application. On Windows Server 2008 this application is *Windows Firewall With Advanced Security* in *Administrative Tools*. On previous versions of Windows Server, access the *Windows Firewall* application in the *System and Security* control panel.

The procedures in this document use the `netsh` command line tool.

14.2.2 Patterns

This section contains a number of patterns and examples for configuring *Windows Firewall‘* for use with MongoDB deployments. If you have configured different ports using the `port` (page 945) configuration setting, you will need to modify the rules accordingly.

Traffic to and from `mongod.exe` Instances

This pattern is applicable to all `mongod.exe` (page 912) instances running as standalone instances or as part of a *replica set*. The goal of this pattern is to explicitly allow traffic to the `mongod.exe` (page 912) instance from the application server.

```
netsh advfirewall firewall add rule name="Open mongod port 27017" dir=in action=allow protocol=TCP lo
```

This rule allows all incoming traffic to port `27017`, which allows the application server to connect to the `mongod.exe` (page 912) instance.

Windows Firewall also allows enabling network access for an entire application rather than to a specific port, as in the following example:

```
netsh advfirewall firewall add rule name="Allowing mongod" dir=in action=allow program=" C:\mongodb\b
```

You can allow all access for a `mongos.exe` (page 913) server, with the following invocation:

```
netsh advfirewall firewall add rule name="Allowing mongos" dir=in action=allow program=" C:\mongodb\b
```

Traffic to and from `mongos.exe` Instances

`mongos.exe` (page 913) instances provide query routing for *sharded clusters*. Clients connect to `mongos.exe` (page 913) instances, which behave from the client's perspective as `mongod.exe` (page 912) instances. In turn, the `mongos.exe` (page 913) connects to all `mongod.exe` (page 912) instances that are components of the sharded cluster.

Use the same *Windows Firewall* command to allow traffic to and from these instances as you would from the `mongod.exe` (page 912) instances that are members of the replica set.

```
netsh advfirewall firewall add rule name="Open mongod shard port 27018" dir=in action=allow protocol=
```

Traffic to and from a MongoDB Config Server

Configuration servers, host the *config database* that stores metadata for sharded clusters. Each production cluster has three configuration servers, initiated using the *`mongod --configsvr`* (page 904) option. [4] Configuration servers listen for connections on port `27019`. As a result, add the following *Windows Firewall* rules to the config server to allow incoming and outgoing connection on port `27019`, for connection to the other config servers.

```
netsh advfirewall firewall add rule name="Open mongod config svr port 27019" dir=in action=allow prot
```

Additionally, config servers need to allow incoming connections from all of the `mongos.exe` (page 913) instances in the cluster *and* all `mongod.exe` (page 912) instances in the cluster. Add rules that resemble the following:

```
netsh advfirewall firewall add rule name="Open mongod config svr inbound" dir=in action=allow protoco
```

Replace `<ip-address>` with the addresses of the `mongos.exe` (page 913) instances and the shard `mongod.exe` (page 912) instances.

[4] You can also run a config server by setting the `configsvr` (page 953) option in a configuration file.

Traffic to and from a MongoDB Shard Server

For shard servers, running as *mongod --shardsvr* (page 904) [5] Because the default port number when running with shardsvr (page 953) is 27018, you must configure the following *Windows Firewall* rules to allow traffic to and from each shard:

```
netsh advfirewall firewall add rule name="Open mongod shardsvr inbound" dir=in action=allow protocol=
netsh advfirewall firewall add rule name="Open mongod shardsvr outbound" dir=out action=allow protoco
```

Replace the <ip-address> specification with the IP address of all mongod.exe (page 912) instances. This allows you to permit incoming and outgoing traffic between all shards including constituent replica set members to:

- all mongod.exe (page 912) instances in the shard's replica sets.
- all mongod.exe (page 912) instances in other shards. [6]

Furthermore, shards need to be able make outgoing connections to:

- all mongos.exe (page 913) instances.
- all mongod.exe (page 912) instances in the config servers.

Create a rule that resembles the following, and replace the <ip-address> with the address of the config servers and the mongos.exe (page 913) instances:

```
netsh advfirewall firewall add rule name="Open mongod config svr outbound" dir=out action=allow proto
```

Provide Access For Monitoring Systems

1. The mongostat (page 931) diagnostic tool, when running with the *--discover* (page 932) needs to be able to reach all components of a cluster, including the config servers, the shard servers, and the mongos.exe (page 913) instances.
2. If your monitoring system needs access the HTTP interface, insert the following rule to the chain:

   ```
   netsh advfirewall firewall add rule name="Open mongod HTTP monitoring inbound" dir=in action=all
   ```

   Replace <ip-address> with the address of the instance that needs access to the HTTP or REST interface. For *all* deployments, you should restrict access to this port to *only* the monitoring instance.

   Optional

   For shard server mongod.exe (page 912) instances running with shardsvr (page 953), the rule would resemble the following:

   ```
   netsh advfirewall firewall add rule name="Open mongos HTTP monitoring inbound" dir=in action=all
   ```

   For config server mongod.exe (page 912) instances running with configsvr (page 953), the rule would resemble the following:

   ```
   netsh advfirewall firewall add rule name="Open mongod configsvr HTTP monitoring inbound" dir=in
   ```

   ---

[5] You can also specify the shard server option using the shardsvr (page 953) setting in the configuration file. Shard members are also often conventional replica sets using the default port.

[6] All shards in a cluster need to be able to communicate with all other shards to facilitate *chunk* and balancing operations.

14.2.3 Manage and Maintain *Windows Firewall* Configurations

This section contains a number of basic operations for managing and using `netsh`. While you can use the GUI front ends to manage the *Windows Firewall*, all core functionality is accessible is accessible from `netsh`.

Delete all *Windows Firewall* Rules

To delete the firewall rule allowing `mongod.exe` (page 912) traffic:

```
netsh advfirewall firewall delete rule name="Open mongod port 27017" protocol=tcp localport=27017
```

```
netsh advfirewall firewall delete rule name="Open mongod shard port 27018" protocol=tcp localport=270
```

List All *Windows Firewall* Rules

To return a list of all *Windows Firewall* rules:

```
netsh advfirewall firewall show rule name=all
```

Reset *Windows Firewall*

To reset the *Windows Firewall* rules:

```
netsh advfirewall reset
```

Backup and Restore *Windows Firewall* Rules

To simplify administration of larger collection of systems, you can export or import firewall systems from different servers) rules very easily on Windows:

Export all firewall rules with the following command:

```
netsh advfirewall export "C:\temp\MongoDBfw.wfw"
```

Replace `"C:\temp\MongoDBfw.wfw"` with a path of your choosing. You can use a command in the following form to import a file created using this operation:

```
netsh advfirewall import "C:\temp\MongoDBfw.wfw"
```

14.3 Control Access to MongoDB Instances with Authentication

MongoDB provides a basic authentication system, that you can enable with the `auth` (page 947) and `keyFile` (page 947) configuration settings. [7] See the *authentication* (page 90) section of the *Security Practices and Management* (page 87) document.

This document contains an overview of all operations related to authentication and managing a MongoDB deployment with authentication.

See Also:

The *Security Considerations* (page 34) section of the *Run-time Database Configuration* (page 33) document for more information on configuring authentication.

[7] Use the `--auth` (page 899) `--keyFile` (page 899) options on the command line.

14.3.1 Add Users

When setting up authentication for the first time you must either:

1. add at least one user to the `admin` database before starting the `mongod` (page 897) instance with `auth` (page 947).
2. add the first user to the `admin` database when connected to the `mongod` (page 897) instance from a `localhost` connection. [8]

Begin by setting up the first administrative user for the `mongod` (page 897) instance.

Add an Administrative User

About administrative users

Administrative users are those users that have "normal" or read and write access to the `admin` database.

If this is the first administrative user, [9] connect to the `mongod` (page 897) on the `localhost` interface using the `mongo` (page 908) shell. Then, issue the following command sequence to switch to the `admin` database context and add the administrative user:

```
use admin
db.addUser("<username>", "<password>")
```

Replace `<username>` and `<password>` with the credentials for this administrative user.

Add a Normal User to a Database

To add a user with read and write access to a specific database, in this example the `records` database, connect to the `mongod` (page 897) instance using the `mongo` (page 908) shell, and issue the following sequence of operations:

```
use records
db.addUser("<username>", "<password>")
```

Replace `<username>` and `<password>` with the credentials for this user.

Add a Read Only User to a Database

To add a user with read only access to a specific database, in this example the `records` database, connect to the `mongod` (page 897) instance using the `mongo` (page 908) shell, and issue the following sequence of operations:

```
use records
db.addUser("<username>", "<password>", true)
```

Replace `<username>` and `<password>` with the credentials for this user.

[8] Because of SERVER-6591, you cannot add the first user to a sharded cluster using the `localhost` connection in 2.2. If you are running a 2.2 sharded cluster, and want to enable authentication, you must deploy the cluster and add the first user to the `admin` database before restarting the cluster to run with `keyFile` (page 947).

[9] You can also use this procedure if authentication is *not* enabled so that your databases has an administrative user when you enable `auth` (page 947).

14.3.2 Administrative Access in MongoDB

Although administrative accounts have access to all databases, these users must authenticate against the `admin` database before changing contexts to a second database, as in the following example:

Example

Given the `superAdmin` user with the password `Password123`, and access to the `admin` database.

The following operation in the `mongo` (page 908) shell will succeed:

```
use admin
db.auth("superAdmin", "Password123")
```

However, the following operation will fail:

```
use test
db.auth("superAdmin", "Password123")
```

Note: If you have authenticated to the `admin` database as normal, read and write, user; logging into a *different* database as a read only user will *not* invalidate the authentication to the `admin` database. In this situation, this client will be able to read and write data to this second database.

14.3.3 Authentication on Localhost

The behavior of `mongod` (page 897) running with `auth` (page 947), when connecting from a client over the localhost interface (i.e. a client running on the same system as the `mongod` (page 897),) varies slightly between before and after version 2.2.

In general if there are no users for the `admin` database, you may connect via the localhost interface. For sharded clusters running version 2.2, if `mongod` (page 897) is running with `auth` (page 947) then all users connecting over the localhost interface must authenticate, even if there aren't any users in the `admin` database.

14.3.4 Password Hashing Insecurity

In version 2.2 and earlier:

- the *normal* users of a database all have access to the `system.users` collection, which contains the user names and a hash of all user's passwords. [10]
- if a user has the same password in multiple databases, the hash will be the same on all database. A malicious user could exploit this to gain access on a second database use a different users' credentials.

As a result, always use unique username and password combinations on for each database.

Thanks to Will Urbanski, from Dell SecureWorks, for identifying this issue.

14.3.5 Configuration Considerations for Authentication

The following sections, outline practices for enabling and managing authentication with specific MongoDB deployments:

[10] Read only users do not have access to the `system.users` database.

- *Security Considerations for Replica Sets* (page 294)
- *Sharded Cluster Security Considerations* (page 371)

14.3.6 Generate a Key File

The key file must be less than one kilobyte in size and may only contain characters in the base64 set. The key file must not have group or "world" permissions on UNIX systems. Key file permissions are not checked on Windows systems.

Windows Systems

Use the following `openssl` command at the system shell to generate pseudo-random content for a key file for deployments with Windows components:

```
openssl rand -base64 741
```

Linux and Unix Systems

Use the following `openssl` command at the system shell to generate pseudo-random content for a key file for systems that do not have Windows components (i.e. OS X, Unix, or Linux systems):

```
openssl rand -base64 753
```

Key File Properties

Be aware that MongoDB strips whitespace characters (e.g. `x0d`, `x09`, and `x20`,) for cross-platform convenience. As a result, the following operations produce identical keys:

```
echo -e "my secret key" > key1
echo -e "my secret key\n" > key2
echo -e "my    secret    key" > key3
echo -e "my\r\nsecret\r\nkey\r\n" > key4
```

Part IV

Core MongoDB Operations (CRUD)

CRUD stands for *create*, *read*, *update*, and *delete*, which are the four core database operations used in database driven application development. The *CRUD Operations for MongoDB* (page 151) section provides introduction to each class of operation along with complete examples of each operation. The documents in the *Read and Write Operations in MongoDB* (page 111) section provide a higher level overview of the behavior and available functionality of these operations.

CHAPTER 15

Read and Write Operations in MongoDB

The *Read Operations* (page 111) and *Write Operations* (page 123) documents provide higher level introductions and description of the behavior and operations of read and write operations for MongoDB deployments. The *BSON Documents* (page 135) provides an overview of *documents* and document-orientation in MongoDB.

15.1 Read Operations

Read operations include all operations that return a cursor in response to application request data (i.e. *queries*,) and also include a number of *aggregation* (page 193) operations that do not return a cursor but have similar properties as queries. These commands include `aggregate` (page 740), `count` (page 750), and `distinct` (page 753).

This document describes the syntax and structure of the queries applications use to request data from MongoDB and how different factors affect the efficiency of reads.

Note: All of the examples in this document use the `mongo` (page 908) shell interface. All of these operations are available in an idiomatic interface for each language by way of the *MongoDB Driver* (page 435). See your driver documentation for full API documentation.

15.1.1 Queries in MongoDB

In the `mongo` (page 908) shell, the `find()` (page 820) and `findOne()` (page 825) methods perform read operations. The `find()` (page 820) method has the following syntax: [1]

```
db.collection.find( <query>, <projection> )
```

- The `db.collection` object specifies the database and collection to query. All queries in MongoDB address a *single* collection.

  You can enter `db` in the `mongo` (page 908) shell to return the name of the current database. Use the `show collections` operation in the `mongo` (page 908) shell to list the current collections in the database.

[1] `db.collection.find()` (page 820) is a wrapper for the more formal query structure with the `$query` (page 712) operator.

- Queries in MongoDB are *BSON* objects that use a set of *query operators* (page 882) to describe query parameters.

  The <query> argument of the find() (page 820) method holds this query document. A read operation without a query document will return all documents in the collection.

- The <projection> argument describes the result set in the form of a document. Projections specify or limit the fields to return.

  Without a projection, the operation will return all fields of the documents. Specify a projection if your documents are larger, or when your application only needs a subset of available fields.

- The order of documents returned by a query is not defined and is not necessarily consistent unless you specify a sort (sort() (page 813)).

For example, the following operation on the inventory collection selects all documents where the type field equals 'food' and the price field has a value less than 9.95. The projection limits the response to the item and qty, and _id field:

```
db.inventory.find( { type: 'food', price: { $lt: 9.95 } },
                   { item: 1, qty: 1 } )
```

The findOne() (page 825) method is similar to the find() (page 820) method except the findOne() (page 825) method returns a single document from a collection rather than a cursor. The method has the syntax:

```
db.collection.findOne( <query>, <projection> )
```

For additional documentation and examples of the main MongoDB read operators, refer to the *Read* (page 159) page of the *Core MongoDB Operations (CRUD)* (page 109) section.

Query Document

This section provides an overview of the query document for MongoDB queries. See the preceding section for more information on *queries in MongoDB* (page 111).

The following examples demonstrate the key properties of the query document in MongoDB queries, using the find() (page 820) method from the mongo (page 908) shell, and a collection of documents named inventory:

- An empty query document ({}) selects all documents in the collection:

  ```
  db.inventory.find( {} )
  ```

  Not specifying a query document to the find() (page 820) is equivalent to specifying an empty query document. Therefore the following operation is equivalent to the previous operation:

  ```
  db.inventory.find()
  ```

- A single-clause query selects all documents in a collection where a field has a certain value. These are simple "equality" queries.

  In the following example, the query selects all documents in the collection where the type field has the value snacks:

  ```
  db.inventory.find( { type: "snacks" } )
  ```

- A single-clause query document can also select all documents in a collection given a condition or set of conditions for one field in the collection's documents. Use the *query operators* (page 882) to specify conditions in a MongoDB query.

  In the following example, the query selects all documents in the collection where the value of the type field is either 'food' or 'snacks':

```
db.inventory.find( { type: { $in: [ 'food', 'snacks' ] } } )
```

Note: Although you can express this query using the $or (page 707) operator, choose the $in (page 698) operator rather than the $or (page 707) operator when performing equality checks on the same field.

- A compound query can specify conditions for more than one field in the collection's documents. Implicitly, a logical AND conjunction connects the clauses of a compound query so that the query selects the documents in the collection that match all the conditions.

  In the following example, the query document specifies an equality match on a single field, followed by a range of values for a second field using a *comparison operator* (page 882):

  ```
  db.inventory.find( { type: 'food', price: { $lt: 9.95 } } )
  ```

  This query selects all documents where the type field has the value 'food' **and** the value of the price field is less than ($lt (page 700)) 9.95.

- Using the $or (page 707) operator, you can specify a compound query that joins each clause with a logical OR conjunction so that the query selects the documents in the collection that match at least one condition.

  In the following example, the query document selects all documents in the collection where the field qty has a value greater than ($gt (page 697)) 100 **or** the value of the price field is less than ($lt (page 700)) 9.95:

  ```
  db.inventory.find( { $or: [ { qty: { $gt: 100 } },
                              { price: { $lt: 9.95 } } ]
                     } )
  ```

- With additional clauses, you can specify precise conditions for matching documents. In the following example, the compound query document selects all documents in the collection where the value of the type field is 'food' **and** *either* the qty has a value greater than ($gt (page 697)) 100 *or* the value of the price field is less than ($lt (page 700)) 9.95:

  ```
  db.inventory.find( { type: 'food', $or: [ { qty: { $gt: 100 } },
                                            { price: { $lt: 9.95 } } ]
                       } )
  ```

Subdocuments

When the field holds an embedded document (i.e. subdocument), you can either specify the entire subdocument as the value of a field, or "reach into" the subdocument using *dot notation*, to specify values for individual fields in the subdocument:

- Equality matches within subdocuments select documents if the subdocument matches *exactly* the specified subdocument, including the field order.

  In the following example, the query matches all documents where the value of the field producer is a subdocument that contains *only* the field company with the value 'ABC123' and the field address with the value '123 Street', in the exact order:

  ```
  db.inventory.find( {
                       producer: {
                                   company: 'ABC123',
                                   address: '123 Street'
                                 }
                     }
                   )
  ```

- Equality matches for specific fields within subdocuments select documents when the field in the subdocument contains a field that matches the specified value.

  In the following example, the query uses the *dot notation* to match all documents where the value of the field `producer` is a subdocument that contains a field `company` with the value `'ABC123'` and may contain other fields:

  ```
  db.inventory.find( { 'producer.company': 'ABC123' } )
  ```

Arrays

When the field holds an array, you can query for values in the array, and if the array holds sub-documents, you query for specific fields within the sub-documents using *dot notation*:

- Equality matches can specify an entire array, to select an array that matches exactly. In the following example, the query matches all documents where the value of the field `tags` is an array and holds three elements, `'fruit'`, `'food'`, and `'citrus'`, in this order:

  ```
  db.inventory.find( { tags: [ 'fruit', 'food', 'citrus' ] } )
  ```

- Equality matches can specify a single element in the array. If the array contains at least *one* element with the specified value, as in the following example: the query matches all documents where the value of the field `tags` is an array that contains, as one of its elements, the element `'fruit'`:

  ```
  db.inventory.find( { tags: 'fruit' } )
  ```

  Equality matches can also select documents by values in an array using the array index (i.e. position) of the element in the array, as in the following example: the query uses the *dot notation* to match all documents where the value of the `tags` field is an array whose first element equals `'fruit'`:

  ```
  db.inventory.find( { 'tags.0' : 'fruit' } )
  ```

In the following examples, consider an array that contains subdocuments:

- If you know the array index of the subdocument, you can specify the document using the subdocument's position.

  The following example selects all documents where the `memos` contains an array whose first element (i.e. index is `0`) is a subdocument with the field `by` with the value `'shipping'`:

  ```
  db.inventory.find( { 'memos.0.by': 'shipping' } )
  ```

- If you do not know the index position of the subdocument, concatenate the name of the field that contains the array, with a dot (`.`) and the name of the field in the subdocument.

  The following example selects all documents where the `memos` field contains an array that contains at least one subdocument with the field `by` with the value `'shipping'`:

  ```
  db.inventory.find( { 'memos.by': 'shipping' } )
  ```

- To match by multiple fields in the subdocument, you can use either dot notation or the `$elemMatch` (page 695) operator:

  The following example uses dot notation to query for documents where the value of the `memos` field is an array that has at least one subdocument that contains the field `memo` equal to `'on time'` and the field `by` equal to `'shipping'`:

  ```
  db.inventory.find(
                     {
  ```

```
                'memos.memo': 'on time',
                'memos.by': 'shipping'
            }
        )
```

The following example uses `$elemMatch` (page 695) to query for documents where the value of the `memos` field is an array that has at least one subdocument that contains the field `memo` equal to `'on time'` and the field `by` equal to `'shipping'`:

```
db.inventory.find( { memos: {
                        $elemMatch: {
                                      memo : 'on time',
                                      by: 'shipping'
                                    }
                     }
                   }
                 )
```

Refer to the *Query, Update, Projection, and Aggregation Operators* (page 691) document for the complete list of query operators.

Result Projections

The *projection* specification limits the fields to return for all matching documents. Restricting the fields to return can minimize network transit costs and the costs of deserializing documents in the application layer.

The second argument to the `find()` (page 820) method is a projection, and it takes the form of a *document* with a list of fields for inclusion or exclusion from the result set. You can either specify the fields to include (e.g. `{ field: 1 }`) or specify the fields to exclude (e.g. `{ field: 0 }`). The `_id` field is implicitly included, unless explicitly excluded.

Note: You cannot combine inclusion and exclusion semantics in a single projection with the *exception* of the `_id` field.

Consider the following projection specifications in `find()` (page 820) operations:

- If you specify no projection, the `find()` (page 820) method returns all fields of all documents that match the query.

  ```
  db.inventory.find( { type: 'food' } )
  ```

  This operation will return all documents in the `inventory` collection where the value of the `type` field is `'food'`.

- A projection can explicitly include several fields. In the following operation, `find()` (page 820) method returns all documents that match the query as well as `item` and `qty` fields. The results also include the `_id` field:

  ```
  db.inventory.find( { type: 'food' }, { item: 1, qty: 1 } )
  ```

- You can remove the `_id` field by excluding it from the projection, as in the following example:

  ```
  db.inventory.find( { type: 'food' }, { item: 1, qty: 1, _id:0 } )
  ```

  This operation returns all documents that match the query, and *only* includes the `item` and `qty` fields in the result set.

- To exclude a single field or group of fields you can use a projection in the following form:

  ```
  db.inventory.find( { type: 'food' }, { type:0 } )
  ```

  This operation returns all documents where the value of the `type` field is `food`, but does not include the `type` field in the output.

  With the exception of the `_id` field you cannot combine inclusion and exclusion statements in projection documents.

The `$elemMatch` (page 722) and `$slice` (page 726) projection operators provide more control when projecting only a portion of an array.

15.1.2 Indexes

Indexes improve the efficiency of read operations by reducing the amount of data that query operations need to process and thereby simplifying the work associated with fulfilling queries within MongoDB. The indexes themselves are a special data structure that MongoDB maintains when inserting or modifying documents, and any given index can: support and optimize specific queries, sort operations, and allow for more efficient storage utilization. For more information about indexes in MongoDB see: *Indexes* (page 239) and *Indexing Overview* (page 241).

You can create indexes using the `db.collection.ensureIndex()` (page 819) method in the `mongo` (page 908) shell, as in the following prototype operation:

```
db.collection.ensureIndex( { <field1>: <order>, <field2>: <order>, ... } )
```

- The `field` specifies the field to index. The field may be a field from a subdocument, using *dot notation* to specify subdocument fields.

  You can create an index on a single field or a *compound index* (page 243) that includes multiple fields in the index.

- The `order` option is specifies either ascending (`1`) or descending (`-1`).

  MongoDB can read the index in either direction. In most cases, you only need to specify *indexing order* (page 244) to support sort operations in compound queries.

Covering a Query

An index *covers* (page 258) a query, a *covered query*, when:

- all the fields in the *query* (page 112) are part of that index, **and**
- all the fields returned in the documents that match the query are in the same index.

For these queries, MongoDB does not need to inspect at documents outside of the index, which is often more efficient than inspecting entire documents.

Example

Given a collection `inventory` with the following index on the `type` and `item` fields:

```
{ type: 1, item: 1 }
```

This index will cover the following query on the `type` and `item` fields, which returns only the `item` field:

```
db.inventory.find( { type: "food", item:/^c/ },
                   { item: 1, _id: 0 } )
```

However, this index will **not** cover the following query, which returns the `item` field **and** the `_id` field:

```
db.inventory.find( { type: "food", item:/^c/ },
                   { item: 1 } )
```

See *Create Indexes that Support Covered Queries* (page 258) for more information on the behavior and use of covered queries.

Measuring Index Use

The `explain()` (page 805) cursor method allows you to inspect the operation of the query system, and is useful for analyzing the efficiency of queries, and for determining how the query uses the index. Call the `explain()` (page 805) method on a cursor returned by `find()` (page 820), as in the following example:

```
db.inventory.find( { type: 'food' } ).explain()
```

Note: Only use `explain()` (page 805) to test the query operation, and *not* the timing of query performance. Because `explain()` (page 805) attempts multiple query plans, it does not reflect accurate query performance.

If the above operation could not use an index, the output of `explain()` (page 805) would resemble the following:

```
{
  "cursor" : "BasicCursor",
  "isMultiKey" : false,
  "n" : 5,
  "nscannedObjects" : 4000006,
  "nscanned" : 4000006,
  "nscannedObjectsAllPlans" : 4000006,
  "nscannedAllPlans" : 4000006,
  "scanAndOrder" : false,
  "indexOnly" : false,
  "nYields" : 2,
  "nChunkSkips" : 0,
  "millis" : 1591,
  "indexBounds" : { },
  "server" : "mongodb0.example.net:27017"
}
```

The `BasicCursor` value in the `cursor` (page 1008) field confirms that this query does not use an index. The `explain.nscannedObjects` (page 1008) value shows that MongoDB must scan 4,000,006 documents to return only 5 documents. To increase the efficiency of the query, create an index on the `type` field, as in the following example:

```
db.inventory.ensureIndex( { type: 1 } )
```

Run the `explain()` (page 805) operation, as follows, to test the use of the index:

```
db.inventory.find( { type: 'food' } ).explain()
```

Consider the results:

```
{
  "cursor" : "BtreeCursor type_1",
  "isMultiKey" : false,
  "n" : 5,
  "nscannedObjects" : 5,
```

```
"nscanned" : 5,
"nscannedObjectsAllPlans" : 5,
"nscannedAllPlans" : 5,
"scanAndOrder" : false,
"indexOnly" : false,
"nYields" : 0,
"nChunkSkips" : 0,
"millis" : 0,
"indexBounds" : { "type" : [
                              [ "food",
                                "food" ]
                            ] },
"server" : "mongodbo0.example.net:27017" }
```

The `BtreeCursor` value of the `cursor` (page 1008) field indicates that the query used an index. This query:

- returned 5 documents, as indicated by the `n` (page 1008) field;
- scanned 5 documents from the index, as indicated by the `nscanned` (page 1008) field;
- then read 5 full documents from the collection, as indicated by the `nscannedObjects` (page 1008) field.

  Although the query uses an index to find the matching documents, if `indexOnly` (page 1009) is false then an index could not *cover* (page 116) the query: MongoDB could not both match the *query conditions* (page 112) **and** return the results using only this index. See *Create Indexes that Support Covered Queries* (page 258) for more information.

Query Optimization

The MongoDB query optimizer processes queries and chooses the most efficient query plan for a query given the available indexes. The query system then uses this query plan each time the query runs. The query optimizer occasionally reevaluates query plans as the content of the collection changes to ensure optimal query plans.

To create a new query plan, the query optimizer:

1. runs the query against several candidate indexes in parallel.
2. records the matches in a common results buffer or buffers.
   - If the candidate plans include only *ordered query plans*, there is a single common results buffer.
   - If the candidate plans include only *unordered query plans*, there is a single common results buffer.
   - If the candidate plans include *both* *ordered query plans* and *unordered query plans*, there are two common results buffers, one for the ordered plans and the other for the unordered plans.

   If an index returns a result already returned by another index, the optimizer skips the duplicate match. In the case of the two buffers, both buffers are de-duped.
3. stops the testing of candidate plans and selects an index when one of the following events occur:
   - An *unordered query plan* has returned all the matching results; *or*
   - An *ordered query plan* has returned all the matching results; *or*
   - An *ordered query plan* has returned a threshold number of matching results:
     - Version 2.0: Threshold is the query batch size. The default batch size is 101.
     - Version 2.2: Threshold is 101.

The selected index becomes the index specified in the query plan; future iterations of this query or queries with the same query pattern will use this index. Query pattern refers to query select conditions that differ only in the values, as in the following two queries with the same query pattern:

```
db.inventory.find( { type: 'food' } )
db.inventory.find( { type: 'utensil' } )
```

To manually compare the performance of a query using more than one index, you can use the `hint()` (page 806) and `explain()` (page 805) methods in conjunction, as in the following prototype:

```
db.collection.find().hint().explain()
```

The following operations each run the same query but will reflect the use of the different indexes:

```
db.inventory.find( { type: 'food' } ).hint( { type: 1 } ).explain()
db.inventory.find( { type: 'food' } ).hint( { type: 1, name: 1 }).explain()
```

This returns the statistics regarding the execution of the query. For more information on the output of `explain()` (page 805), see the *Explain Output* (page 1006).

Note: If you run `explain()` (page 805) without including `hint()` (page 806), the query optimizer reevaluates the query and runs against multiple indexes before returning the query statistics.

As collections change over time, the query optimizer deletes a query plan and reevaluates the after any of the following events:

- the collection receives 1,000 write operations.
- the `reIndex` (page 784) rebuilds the index.
- you add or drop an index.
- the `mongod` (page 897) process restarts.

For more information, see *Indexing Strategies* (page 257).

Query Operations that Cannot Use Indexes Effectively

Some query operations cannot use indexes effectively or cannot use indexes at all. Consider the following situations:

- The inequality operators `$nin` (page 705) and `$ne` (page 704) are not very selective, as they often match a large portion of the index.

  As a result, in most cases, a `$nin` (page 705) or `$ne` (page 704) query with an index may perform no better than a `$nin` (page 705) or `$ne` (page 704) query that must scan all documents in a collection.

- Queries that specify regular expressions, with inline JavaScript regular expressions or `$regex` (page 713) operator expressions, cannot use an index. *However*, the regular expression with anchors to the beginning of a string *can* use an index.

15.1.3 Cursors

The `find()` (page 820) method returns a *cursor* to the results; however, in the `mongo` (page 908) shell, if the returned cursor is not assigned to a variable, then the cursor is automatically iterated up to 20 times [2] to print up to the first 20 documents that match the query, as in the following example:

[2] You can use the `DBQuery.shellBatchSize` to change the number of iteration from the default value `20`. See *Executing Queries* (page 466) for more information.

```
db.inventory.find( { type: 'food' } );
```

When you assign the `find()` (page 820) to a variable:

- you can call the cursor variable in the shell to iterate up to 20 times [2] and print the matching documents, as in the following example:

  ```
  var myCursor = db.inventory.find( { type: 'food' } );

  myCursor
  ```

- you can use the cursor method `next()` (page 811) to access the documents, as in the following example:

  ```
  var myCursor = db.inventory.find( { type: 'food' } );
  var myDocument = myCursor.hasNext() ? myCursor.next() : null;

  if (myDocument) {
      var myItem = myDocument.item;
      print(tojson(myItem));
  }
  ```

  As an alternative print operation, consider the `printjson()` helper method to replace `print(tojson())`:

  ```
  if (myDocument) {
      var myItem = myDocument.item;
      printjson(myItem);
  }
  ```

- you can use the cursor method `forEach()` (page 806) to iterate the cursor and access the documents, as in the following example:

  ```
  var myCursor =  db.inventory.find( { type: 'food' } );

  myCursor.forEach(printjson);
  ```

See *JavaScript cursor methods* (page 890) and your *driver* (page 435) documentation for more information on cursor methods.

Iterator Index

In the `mongo` (page 908) shell, you can use the `toArray()` (page 814) method to iterate the cursor and return the documents in an array, as in the following:

```
var myCursor = db.inventory.find( { type: 'food' } );
var documentArray = myCursor.toArray();
var myDocument = documentArray[3];
```

The `toArray()` (page 814) method loads into RAM all documents returned by the cursor; the `toArray()` (page 814) method exhausts the cursor.

Additionally, some *drivers* (page 435) provide access to the documents by using an index on the cursor (i.e. `cursor[index]`). This is a shortcut for first calling the `toArray()` (page 814) method and then using an index on the resulting array.

Consider the following example:

```
var myCursor = db.inventory.find( { type: 'food' } );
var myDocument = myCursor[3];
```

The `myCursor[3]` is equivalent to the following example:

```
myCursor.toArray() [3];
```

Cursor Behaviors

Consider the following behaviors related to cursors:

- By default, the server will automatically close the cursor after 10 minutes of inactivity or if client has exhausted the cursor. To override this behavior, you can specify the `noTimeout` wire protocol flag in your query; however, you should either close the cursor manually or exhaust the cursor. In the `mongo` (page 908) shell, you can set the `noTimeout` flag:

  ```
  var myCursor = db.inventory.find().addOption(DBQuery.Option.noTimeout);
  ```

  See your *driver* (page 435) documentation for information on setting the `noTimeout` flag. See *Cursor Flags* (page 122) for a complete list of available cursor flags.

- Because the cursor is not isolated during its lifetime, intervening write operations may result in a cursor that returns a single document [3] more than once. To handle this situation, see the information on *snapshot mode* (page 647).

- The MongoDB server returns the query results in batches:

  - For most queries, the *first* batch returns 101 documents or just enough documents to exceed 1 megabyte. Subsequent batch size is 4 megabytes. To override the default size of the batch, see `batchSize()` (page 804) and `limit()` (page 807).
  - For queries that include a sort operation *without* an index, the server must load all the documents in memory to perform the sort and will return all documents in the first batch.
  - Batch size will not exceed the *maximum BSON document size* (page 1021).
  - As you iterate through the cursor and reach the end of the returned batch, if there are more results, `cursor.next()` (page 811) will perform a `getmore operation` (page 1000) to retrieve the next batch.

    To see how many documents remain in the batch as you iterate the cursor, you can use the `objsLeftInBatch()` (page 811) method, as in the following example:

    ```
    var myCursor = db.inventory.find();

    var myFirstDocument = myCursor.hasNext() ? myCursor.next() : null;

    myCursor.objsLeftInBatch();
    ```

- You can use the command `cursorInfo` (page 752) to retrieve the following information on cursors:

  - total number of open cursors
  - size of the client cursors in current use
  - number of timed out cursors since the last server restart

  Consider the following example:

  ```
  db.runCommand( { cursorInfo: 1 } )
  ```

  The result from the command returns the following documentation:

[3] A single document relative to value of the `_id` field. A cursor cannot return the same document more than once *if* the document has not changed.

```
{ "totalOpen" : <number>, "clientCursors_size" : <number>, "timedOut" : <number>, "ok" : 1 }
```

Cursor Flags

The mongo (page 908) shell provides the following cursor flags:

- DBQuery.Option.tailable
- DBQuery.Option.slaveOk
- DBQuery.Option.oplogReplay
- DBQuery.Option.noTimeout
- DBQuery.Option.awaitData
- DBQuery.Option.exhaust
- DBQuery.Option.partial

Aggregation

Changed in version 2.2. MongoDB can perform some basic data aggregation operations on results before returning data to the application. These operations are not queries; they use *database commands* rather than queries, and they do not return a cursor. However, they still require MongoDB to read data.

Running aggregation operations on the database side can be more efficient than running them in the application layer and can reduce the amount of data MongoDB needs to send to the application. These aggregation operations include basic grouping, counting, and even processing data using a map reduce framework. Additionally, in 2.2 MongoDB provides a complete aggregation framework for more rich aggregation operations.

The aggregation framework provides users with a "pipeline" like framework: documents enter from a collection and then pass through a series of steps by a sequence of *pipeline operators* (page 212) that manipulate and transform the documents until they're output at the end. The aggregation framework is accessible via the aggregate (page 740) command or the db.collection.aggregate() (page 815) helper in the mongo (page 908) shell.

For more information on the aggregation framework see *Aggregation* (page 193).

Additionally, MongoDB provides a number of simple data aggregation operations for more basic data aggregation operations:

- count (page 750) (count() (page 804))
- distinct (page 753) (db.collection.distinct() (page 817))
- group (page 769) (db.collection.group() (page 828))
- mapReduce (page 775). (Also consider mapReduce() (page 832) and *Map-Reduce* (page 223).)

15.1.4 Architecture

Read Operations from Sharded Clusters

Sharded clusters allow you to partition a data set among a cluster of mongod (page 897) in a way that is nearly transparent to the application. See the *Sharding* (page 363) section of this manual for additional information about these deployments.

For a sharded cluster, you issue all operations to one of the mongos (page 905) instances associated with the cluster. mongos (page 905) instances route operations to the mongod (page 897) in the cluster and behave like mongod

(page 897) instances to the application. Read operations to a sharded collection in a sharded cluster are largely the same as operations to a *replica set* or *standalone* instances. See the section on *Read Operations in Sharded Clusters* (page 369) for more information.

In sharded deployments, the `mongos` (page 905) instance routes the queries from the clients to the `mongod` (page 897) instances that hold the data, using the cluster metadata stored in the *config database* (page 368).

For sharded collections, if queries do not include the *shard key* (page 365), the `mongos` (page 905) must direct the query to all shards in a collection. These *scatter gather* queries can be inefficient, particularly on larger clusters, and are unfeasible for routine operations.

For more information on read operations in sharded clusters, consider the following resources:

- *An Introduction to Shard Keys* (page 365)
- *Shard Key Internals and Operations* (page 374)
- *Querying Sharded Clusters* (page 376)
- *Sharded Cluster Operations and mongos Instances* (page 369)

Read Operations from Replica Sets

Replica sets use *read preferences* to determine where and how to route read operations to members of the replica set. By default, MongoDB always reads data from a replica set's *primary*. You can modify that behavior by changing the *read preference mode* (page 306).

You can configure the *read preference mode* (page 306) on a per-connection or per-operation basis to allow reads from *secondaries* to:

- reduce latency in multi-data-center deployments,
- improve read throughput by distributing high read-volumes (relative to write volume),
- for backup operations, and/or
- to allow reads during *failover* (page 280) situations.

Read operations from secondary members of replica sets are not guaranteed to reflect the current state of the primary, and the state of secondaries will trail the primary by some amount of time. Often, applications don't rely on this kind of strict consistency, but application developers should always consider the needs of their application before setting read preference.

For more information on *read preferences* (page 306) or on the read preference modes, see *Read Preference* (page 306) and *Read Preference Modes* (page 306).

15.2 Write Operations

All operations that create or modify data in the MongoDB instance are write operations. MongoDB represents data as *BSON documents* stored in *collections*. Write operations target one collection and are atomic on the level of a single document: no single write operation can atomically affect more than one document or more than one collection.

This document introduces the write operators available in MongoDB as well as presents strategies to increase the efficiency of writes in applications.

15.2.1 Write Operators

For information on write operators and how to write data to a MongoDB database, see the following pages:

- *Create* (page 151)
- *Update* (page 169)
- *Delete* (page 175)

For information on specific methods used to perform write operations in the `mongo` (page 908) shell, see the following:

- `db.collection.insert()` (page 830)
- `db.collection.update()` (page 842)
- `db.collection.save()` (page 840)
- `db.collection.findAndModify()` (page 822)
- `db.collection.remove()` (page 838)

For information on how to perform write operations from within an application, see the *MongoDB Drivers and Client Libraries* (page 435) documentation or the documentation for your client library.

15.2.2 Write Concern

Note: The *driver write concern* (page 1061) change created a new connection class in all of the MongoDB drivers, called `MongoClient` with a different default write concern. See the *release notes* (page 1061) for this change, and the release notes for the driver you're using for more information about your driver's release.

Operational Considerations and Write Concern

Clients issue write operations with some level of *write concern*, which describes the level of concern or guarantee the server will provide in its response to a write operation. Consider the following levels of conceptual write concern:

- *errors ignored*: Write operations are not acknowledged by MongoDB, and may not succeed in the case of connection errors that the client is not yet aware of, or if the `mongod` (page 897) produces an exception (e.g. a duplicate key exception for *unique indexes* (page 246).) While this operation is efficient because it does not require the database to respond to every write operation, it also incurs a significant risk with regards to the persistence and durability of the data.

  Warning: Do not use this option in normal operation.

- *unacknowledged*: MongoDB does not acknowledge the receipt of write operation as with a write concern level of *ignore*; however, the driver will receive and handle network errors, as possible given system networking configuration.

  Before the releases outlined in *Default Write Concern Change* (page 1061), this was the default write concern.

- receipt *acknowledged*: The `mongod` (page 897) will confirm the receipt of the write operation, allowing the client to catch network, duplicate key, and other exceptions. After the releases outlined in *Default Write Concern Change* (page 1061), this is the default write concern. [4]

- *journaled*: The `mongod` (page 897) will confirm the write operation only after it has written the operation to the *journal*. This confirms that the write operation can survive a `mongod` (page 897) shutdown and ensures that the write operation is durable.

[4] The default write concern is to call `getLastError` (page 766) with no arguments. For replica sets, you can define the default write concern settings in the `getLastErrorDefaults` (page 992) If `getLastErrorDefaults` (page 992) does not define a default write concern setting, `getLastError` (page 766) defaults to basic receipt acknowledgment.

While receipt *acknowledged* without *journaled* provides the fundamental basis for write concern, there is an up-to 100 millisecond window between journal commits where the write operation is not fully durable. Require *journaled* as part of the write concern to provide this durability guarantee.

Replica sets present an additional layer of consideration for write concern. Basic write concern levels affect the write operation on only one `mongod` (page 897) instance. The `w` argument to `getLastError` (page 766) provides a *replica acknowledged* level of write concern. With *replica acknowledged* you can guarantee that the write operation has propagated to the members of a replica set. See the *Write Concern for Replica Sets* (page 303) document for more information.

Note: Requiring *journaled* write concern in a replica set only requires a journal commit of the write operation to the *primary* of the set regardless of the level of *replica acknowledged* write concern.

Internal Operation of Write Concern

To provide write concern, *drivers* (page 435) issue the `getLastError` (page 766) command after a write operation and receive a document with information about the last operation. This document's `err` field contains either:

- `null`, which indicates the write operations have completed successfully, or
- a description of the last error encountered.

The definition of a "successful write" depends on the arguments specified to `getLastError` (page 766), or in replica sets, the configuration of `getLastErrorDefaults` (page 992). When deciding the level of write concern for your application, become familiar with the *Operational Considerations and Write Concern* (page 124).

The `getLastError` (page 766) command has the following options to configure write concern requirements:

- `j` or "journal" option

  This option confirms that the `mongod` (page 897) instance has written the data to the on-disk journal and ensures data is not lost if the `mongod` (page 897) instance shuts down unexpectedly. Set to `true` to enable, as shown in the following example:

  ```
  db.runCommand( { getLastError: 1, j: "true" } )
  ```

  If you set `journal` (page 948) to true, and the `mongod` (page 897) does not have journaling enabled, as with `nojournal` (page 949), then `getLastError` (page 766) will provide basic receipt acknowledgment, and will include a `jnote` field in its return document.

- `w` option

  This option provides the ability to disable write concern entirely *as well as* specifies the write concern operations for *replica sets*. See *Operational Considerations and Write Concern* (page 124) for an introduction to the fundamental concepts of write concern. By default, the `w` option is set to `1`, which provides basic receipt acknowledgment on a single `mongod` (page 897) instance or on the *primary* in a replica set.

  The `w` option takes the following values:

  - `-1`:

    Disables all acknowledgment of write operations, and suppresses all including network and socket errors.

  - `0`:

    Disables basic acknowledgment of write operations, but returns information about socket excepts and networking errors to the application.

Note: If you disable basic write operation acknowledgment but require journal commit acknowledgment, the journal commit prevails, and the driver will require that `mongod` (page 897) will acknowledge the replica set.

- `1`:

  Provides acknowledgment of write operations on a standalone `mongod` (page 897) or the *primary* in a replica set.

- *A number greater than 1*:

  Guarantees that write operations have propagated successfully to the specified number of replica set members including the primary. If you set `w` to a number that is greater than the number of set members that hold data, MongoDB waits for the non-existent members to become available, which means MongoDB blocks indefinitely.

- `majority`:

  Confirms that write operations have propagated to the majority of configured replica set: nodes must acknowledge the write operation before it succeeds. This ensures that write operation will *never* be subject to a rollback in the course of normal operation, and furthermore allows you to prevent hard coding assumptions about the size of your replica set into your application.

- *A tag set*:

  By specifying a *tag set* (page 994) you can have fine-grained control over which replica set members must acknowledge a write operation to satisfy the required level of write concern.

`getLastError` (page 766) also supports a `wtimeout` setting which allows clients to specify a timeout for the write concern: if you don't specify `wtimeout` and the `mongod` (page 897) cannot fulfill the write concern the `getLastError` (page 766) will block, potentially forever.

For more information on write concern and replica sets, see *Write Concern for Replica Sets* (page 303) for more information..

In sharded clusters, `mongos` (page 905) instances will pass write concern on to the shard `mongod` (page 897) instances.

15.2.3 Bulk Inserts

In some situations you may need to insert or ingest a large amount of data into a MongoDB database. These *bulk inserts* have some special considerations that are different from other write operations.

The `insert()` (page 830) method, when passed an array of documents, will perform a bulk insert, and inserts each document atomically. *Drivers* (page 435) provide their own interface for this kind of operation. New in version 2.2: `insert()` (page 830) in the `mongo` (page 908) shell gained support for bulk inserts in version 2.2. Bulk insert can significantly increase performance by amortizing *write concern* (page 124) costs. In the drivers, you can configure write concern for batches rather than on a per-document level.

Drivers also have a `ContinueOnError` option in their insert operation, so that the bulk operation will continue to insert remaining documents in a batch even if an insert fails.

Note: New in version 2.0: Support for `ContinueOnError` depends on version 2.0 of the core `mongod` (page 897) and `mongos` (page 905) components.

If the bulk insert process generates more than one error in a batch job, the client will only receive the most recent error. All bulk operations to a *sharded collection* run with `ContinueOnError`, which applications cannot disable.

See *Strategies for Bulk Inserts in Sharded Clusters* (page 395) section for more information on consideration for bulk inserts in sharded clusters.

For more information see your *driver documentation* (page 435) for details on performing bulk inserts in your application. Also consider the following resources: *Sharded Clusters* (page 129), *Strategies for Bulk Inserts in Sharded Clusters* (page 395), and *Importing and Exporting MongoDB Data* (page 63).

15.2.4 Indexing

After every insert, update, or delete operation, MongoDB must update *every* index associated with the collection in addition to the data itself. Therefore, every index on a collection adds some amount of overhead for the performance of write operations. [5]

In general, the performance gains that indexes provide for *read operations* are worth the insertion penalty; however, when optimizing write performance, be careful when creating new indexes and always evaluate the indexes on the collection and ensure that your queries are actually using these indexes.

For more information on indexes in MongoDB consider *Indexes* (page 239) and *Indexing Strategies* (page 257).

15.2.5 Isolation

When a single write operation modifies multiple documents, the operation as a whole is not atomic, and other operations may interleave. The modification of a single document, or record, is always atomic, even if the write operation modifies multiple sub-document *within* the single record.

No other operations are atomic; however, you can attempt to isolate a write operation that affects multiple documents using the *isolation operator* (page 699).

To isolate a sequence of write operations from other read and write operations, see *Perform Two Phase Commits* (page 445).

15.2.6 Updates

Each document in a MongoDB collection has allocated *record* space which includes the entire document *and* a small amount of padding. This padding makes it possible for update operations to increase the size of a document slightly without causing the document to outgrow the allocated record size.

Documents in MongoDB can grow up to the full maximum `BSON document size` (page 1021). However, when documents outgrow their allocated record size MongoDB must allocate a new record and move the document to the new record. Update operations that do not cause a document to grow, (i.e. *in-place* updates,) are significantly more efficient than those updates that cause document growth. Use *data models* (page 131) that minimize the need for document growth when possible.

For complete examples of update operations, see *Update* (page 169).

15.2.7 Padding Factor

If an update operation does not cause the document to increase in size, MongoDB can apply the update in-place. Some updates change the size of the document, for example using the `$push` (page 711) operator to append a sub-document to an array can cause the top level document to grow beyond its allocated space.

[5] The overhead for *sparse indexes* (page 246) inserts and updates to un-indexed fields is less than for non-sparse indexes. Also for non-sparse indexes, updates that don't change the record size have less indexing overhead.

When documents grow, MongoDB relocates the document on disk with enough contiguous space to hold the document. These relocations take longer than in-place updates, particularly if the collection has indexes that MongoDB must update all index entries. If collection has many indexes, the move will impact write throughput.

To minimize document movements, MongoDB employs padding. MongoDB adaptively learns if documents in a collection tend to grow, and if they do, adds a `paddingFactor` (page 982) so that the documents have room to grow on subsequent writes. The `paddingFactor` (page 982) indicates the padding for new inserts and moves. New in version 2.2: You can use the `collMod` (page 744) command with the `usePowerOf2Sizes` (page 744) flag so that MongoDB allocates document space in sizes that are powers of 2. This helps ensure that MongoDB can efficiently reuse the space freed as a result of deletions or document relocations. As with all padding, using document space allocations with power of 2 sizes minimizes, but does not eliminate, document movements. To check the current `paddingFactor` (page 982) on a collection, you can run the `db.collection.stats()` (page 841) operation in the `mongo` (page 908) shell, as in the following example:

```
db.myCollection.stats()
```

Since MongoDB writes each document at a different point in time, the padding for each document will not be the same. You can calculate the padding size by subtracting 1 from the `paddingFactor` (page 982), for example:

```
padding size = (paddingFactor - 1) * <document size>.
```

For example, a `paddingFactor` (page 982) of `1.0` specifies no padding whereas a paddingFactor of `1.5` specifies a padding size of `0.5` or 50 percent (50%) of the document size.

Because the `paddingFactor` (page 982) is relative to the size of each document, you cannot calculate the exact amount of padding for a collection based on the average document size and padding factor.

If an update operation causes the document to *decrease* in size, for instance if you perform an `$unset` (page 720) or a `$pop` (page 709) update, the document remains in place and effectively has more padding. If the document remains this size, the space is not reclaimed until you perform a `compact` (page 746) or a `repairDatabase` (page 787) operation.

Note: The following operations remove padding:

- `compact` (page 746),
- `repairDatabase` (page 787), and
- initial replica sync operations.

However, with the `compact` (page 746) command, you can run the command with a `paddingFactor` or a `paddingBytes` parameter.

Padding is also removed if you use `mongoexport` (page 928) from a collection. If you use `mongoimport` (page 925) into a new collection, `mongoimport` (page 925) will not add padding. If you use `mongoimport` (page 925) with an existing collection with padding, `mongoimport` (page 925) will not affect the existing padding.

When a database operation removes padding, subsequent update that require changes in record sizes will have reduced throughput until the collection's padding factor grows. Padding does not affect in-place, and after `compact` (page 746), `repairDatabase` (page 787), and replica set initial sync the collection will require less storage.

See Also:

- *Can I manually pad documents to prevent moves during updates?* (page 648)
- Fast Updates with MongoDB with in-place Updates (blog post)

15.2.8 Architecture

Replica Sets

In *replica sets*, all write operations go to the set's *primary*, which applies the write operation then records the operations on the primary's operation log or *oplog*. The oplog is a reproducible sequence of operations to the data set. *Secondary* members of the set are continuously replicating the oplog and applying the operations to themselves in an asynchronous process.

Large volumes of write operations, particularly bulk operations, may create situations where the secondary members have difficulty applying the replicating operations from the primary at a sufficient rate: this can cause the secondary's state to fall behind that of the primary. Secondaries that are significantly behind the primary present problems for normal operation of the replica set, particularly *failover* (page 298) in the form of *rollbacks* (page 281) as well as general *read consistency* (page 281).

To help avoid this issue, you can customize the *write concern* (page 124) to return confirmation of the write operation to another member [6] of the replica set every 100 or 1,000 operations. This provides an opportunity for secondaries to catch up with the primary. Write concern can slow the overall progress of write operations but ensure that the secondaries can maintain a largely current state with respect to the primary.

For more information on replica sets and write operations, see *Write Concern* (page 303), *Oplog* (page 282), *Oplog Internals* (page 312), and *Changing Oplog Size* (page 293).

Sharded Clusters

In a *sharded cluster*, MongoDB directs a given write operation to a *shard* and then performs the write on a particular *chunk* on that shard. Shards and chunks are range-based. *Shard keys* affect how MongoDB distributes documents among shards. Choosing the correct shard key can have a great impact on the performance, capability, and functioning of your database and cluster.

For more information, see *Sharded Cluster Administration* (page 368) and *Bulk Inserts* (page 126).

[6] Calling `getLastError` (page 766) intermittently with a `w` value of `2` or `majority` will slow the throughput of write traffic; however, this practice will allow the secondaries to remain current with the state of the primary.

CHAPTER 16

Document Orientation Concepts

16.1 Data Modeling Considerations for MongoDB Applications

16.1.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. This means that:

- documents in the same collection do not need to have the same set of fields or structure, and
- common fields in a collection's documents may hold different types of data.

Each document only needs to contain relevant fields to the entity or object that the document represents. In practice, *most* documents in a collection share a similar structure. Schema flexibility means that you can model your documents in MongoDB so that they can closely resemble and reflect application-level objects.

As in all data modeling, when developing data models (i.e. *schema designs,*) for MongoDB you must consider the inherent properties and requirements of the application objects and the relationships between application objects. MongoDB data models must also reflect:

- how data will grow and change over time, and
- the kinds of queries your application will perform.

These considerations and requirements force developers to make a number of multi-factored decisions when modeling data, including:

- normalization and de-normalization.

  These decisions reflect degree to which the data model should store related pieces of data in a single document **or** should the data model describe relationships using *references* (page 144) between documents.

- *indexing strategy* (page 257).
- representation of data in arrays in *BSON*.

Although a number of data models may be functionally equivalent for a given application; however, different data models may have significant impacts on MongoDB and applications performance.

This document provides a high level overview of these data modeling decisions and factors. In addition, consider, the *Data Modeling Patterns and Examples* (page 135) section which provides more concrete examples of all the discussed patterns.

16.1.2 Data Modeling Decisions

Data modeling decisions involve determining how to structure the documents to model the data effectively. The primary decision is whether to *embed* (page 132) or to *use references* (page 132).

Embedding

To de-normalize data, store two related pieces of data in a single *document*.

Operations within a document are less expensive for the server than operations that involve multiple documents.

In general, use embedded data models when:

- you have "contains" relationships between entities. See *Model Embedded One-to-One Relationships Between Documents* (page 179).
- you have one-to-many relationships where the "many" objects always appear with or are viewed in the context of their parent documents. See *Model Embedded One-to-Many Relationships Between Documents* (page 180).

Embedding provides the following benefits:

- generally better performance for read operations.
- the ability to request and retrieve related data in a single database operation.

Embedding related data in documents, can lead to situations where documents grow after creation. Document growth can impact write performance and lead to data fragmentation. Furthermore, documents in MongoDB must be smaller than the `maximum BSON document size` (page 1021). For larger documents, consider using *GridFS* (page 146).

For examples in accessing embedded documents, see *Subdocuments* (page 113).

See Also:

- *dot notation* for information on "reaching into" embedded sub-documents.
- *Arrays* (page 114) for more examples on accessing arrays
- *Subdocuments* (page 113) for more examples on accessing subdocuments

Referencing

To normalize data, store *references* (page 144) between two documents to indicate a relationship between the data represented in each document.

In general, use normalized data models:

- when embedding would result in duplication of data but would not provide sufficient read performance advantages to outweigh the implications of the duplication.
- to represent more complex many-to-many relationships.
- to model large hierarchical data sets. See *data-modeling-trees*.

Referencing provides more flexibility than embedding; however, to resolve the references, client-side applications must issue follow-up queries. In other words, using references requires more roundtrips to the server.

See *Model Referenced One-to-Many Relationships Between Documents* (page 181) for an example of referencing.

Atomicity

MongoDB only provides atomic operations on the level of a single document. [1] As a result needs for atomic operations influence decisions to use embedded or referenced relationships when modeling data for MongoDB.

Embed fields that need to be modified together atomically in the same document. See *Model Data for Atomic Operations* (page 183) for an example of atomic updates within a single document.

16.1.3 Operational Considerations

In addition to normalization and normalization concerns, a number of other operational factors help shape data modeling decisions in MongoDB. These factors include:

- data lifecycle management,
- number of collections and
- indexing requirements,
- sharding, and
- managing document growth.

These factors implications for database and application performance as well as future maintenance and development costs.

Data Lifecycle Management

Data modeling decisions should also take data lifecycle management into consideration.

The *Time to Live or TTL feature* (page 458) of collections expires documents after a period of time. Consider using the TTL feature if your application requires some data to persist in the database for a limited period of time.

Additionally, if your application only uses recently inserted documents consider *Capped Collections* (page 440). Capped collections provide *first-in-first-out* (FIFO) management of inserted documents and optimized to support operations that insert and read documents based on insertion order.

Large Number of Collections

In certain situations, you might choose to store information in several collections rather than in a single collection.

Consider a sample collection `logs` that stores log documents for various environment and applications. The `logs` collection contains documents of the following form:

```
{ log: "dev", ts: ..., info: ... }
{ log: "debug", ts: ..., info: ...}
```

If the total number of documents is low you may group documents into collection by type. For logs, consider maintaining distinct log collections, such as `logs.dev` and `logs.debug`. The `logs.dev` collection would contain only the documents related to the dev environment.

Generally, having large number of collections has no significant performance penalty and results in very good performance. Distinct collections are very important for high-throughput batch processing.

When using models that have a large number of collections, consider the following behaviors:

- Each collection has a certain minimum overhead of a few kilobytes.

[1] Document-level atomic operations include all operations within a single MongoDB document record: operations that affect multiple subdocuments within that single record are still atomic.

- Each index, including the index on _id, requires at least 8KB of data space.

A single <database>.ns file stores all meta-data for each *database*. Each index and collection has its own entry in the namespace file, MongoDB places limits on the size of namespace files. (page 1021).

Because of limits on namespaces (page 1021), you may wish to know the current number of namespaces in order to determine how many additional namespaces the database can support, as in the following example:

```
db.system.namespaces.count()
```

The <database>.ns file defaults to 16 MB. To change the size of the <database>.ns file, pass a new size to *--nssize option <new size MB>* (page 901) on server start.

The *--nssize* (page 901) sets the size for *new* <database>.ns files. For existing databases, after starting up the server with *--nssize* (page 901), run the db.repairDatabase() (page 853) command from the mongo (page 908) shell.

Indexes

Create indexes to support common queries. Generally, indexes and index use in MongoDB correspond to indexes and index use in relational database: build indexes on fields that appear often in queries and for all operations that return sorted results. MongoDB automatically creates a unique index on the _id field.

As you create indexes, consider the following behaviors of indexes:

- Each index requires at least 8KB of data space.
- Adding an index has some negative performance impact for write operations. For collections with high write-to-read ratio, indexes are expensive as each insert must add keys to each index.
- Collections with high proportion of read operations to write operations often benefit from additional indexes. Indexes do not affect un-indexed read operations.

See *Indexing Strategies* (page 257) for more information on determining indexes. Additionally, the MongoDB *database profiler* (page 616) may help identify inefficient queries.

Sharding

Sharding allows users to *partition* a *collection* within a database to distribute the collection's documents across a number of mongod (page 897) instances or *shards*.

The shard key determines how MongoDB distributes data among shards in a sharded collection. Selecting the proper *shard key* (page 365) has significant implications for performance.

See *Sharded Cluster Overview* (page 365) for more information on sharding and the selection of the *shard key* (page 365).

Document Growth

Certain updates to documents can increase the document size, such as pushing elements to an array and adding new fields. If the document size exceeds the allocated space for that document, MongoDB relocates the document on disk. This internal relocation can be both time and resource consuming.

Although MongoDB automatically provides padding to minimize the occurrence of relocations, you may still need to manually handle document growth. Refer to *Pre-Aggregated Reports* (page 501) for an example of the *Pre-allocation* approach to handle document growth.

16.1.4 Data Modeling Patterns and Examples

The following documents provide overviews of various data modeling patterns and common schema design considerations:

- *Model Embedded One-to-One Relationships Between Documents* (page 179)
- *Model Embedded One-to-Many Relationships Between Documents* (page 180)
- *Model Referenced One-to-Many Relationships Between Documents* (page 181)
- *Model Data for Atomic Operations* (page 183)
- *Model Tree Structures with Parent References* (page 184)
- *Model Tree Structures with Child References* (page 184)
- *Model Tree Structures with Materialized Paths* (page 186)
- *Model Tree Structures with Nested Sets* (page 187)

For more information and examples of real-world data modeling, consider the following external resources:

- Schema Design by Example
- Walkthrough MongoDB Data Modeling
- Document Design for MongoDB
- Dynamic Schema Blog Post
- MongoDB Data Modeling and Rails
- Ruby Example of Materialized Paths
- Sean Cribs Blog Post which was the source for much of the *data-modeling-trees* content.

16.2 BSON Documents

MongoDB is a document-based database system, and as a result, all records, or data, in MongoDB are documents. Documents are the default representation of most user accessible data structures in the database. Documents provide structure for data in the following MongoDB contexts:

- the *records* (page 137) stored in *collections*
- the *query selectors* (page 139) that determine which records to select for read, update, and delete operations
- the *update actions* (page 139) that specify the particular field updates to perform during an update operation
- the specification of *indexes* (page 140) for collection.
- arguments to several MongoDB methods and operators, including:
  - *sort order* (page 140) for the `sort()` (page 813) method.
  - *index specification* (page 140) for the `hint()` (page 806) method.
- the output of a number of MongoDB commands and operations, including:
  - the *output* (page 980) of `collStats` (page 745) command, and
  - the *output* (page 965) of the `serverStatus` (page 792) command.

16.2.1 Structure

The document structure in MongoDB are *BSON* objects with support for the full range of *BSON types*; however, BSON documents are conceptually, similar to *JSON* objects, and have the following structure:

```
{
   field1: value1,
   field2: value2,
   field3: value3,
   ...
   fieldN: valueN
}
```

Having support for the full range of BSON types, MongoDB documents may contain field and value pairs where the value can be another document, an array, an array of documents as well as the basic types such as `Double`, `String`, and `Date`. See also *BSON Type Considerations* (page 141).

Consider the following document that contains values of varying types:

```
var mydoc = {
               _id: ObjectId("5099803df3f4948bd2f98391"),
               name: { first: "Alan", last: "Turing" },
               birth: new Date('Jun 23, 1912'),
               death: new Date('Jun 07, 1954'),
               contribs: [ "Turing machine", "Turing test", "Turingery" ],
               views : NumberLong(1250000)
             }
```

The document contains the following fields:

- `_id` that holds an *ObjectId*.
- `name` that holds a *subdocument* that contains the fields `first` and `last`.
- `birth` and `death`, which both have *Date* types.
- `contribs` that holds an *array of strings*.
- `views` that holds a value of *NumberLong* type.

All field names are strings in *BSON* documents. Be aware that there are some `restrictions on field names` (page 1023) for *BSON* documents: field names cannot contain null characters, dots (`.`), or dollar signs (`$`).

Note: BSON documents may have more than one field with the same name; however, most *MongoDB Interfaces* (page 435) represent MongoDB with a structure (e.g. a hash table) that does not support duplicate field names. If you need to manipulate documents that have more than one field with the same name, see your driver's documentation for more information.

Some documents created by internal MongoDB processes may have duplicate fields, but *no* MongoDB process will *ever* add duplicate keys to an existing user document.

Type Operators

To determine the type of fields, the `mongo` (page 908) shell provides the following operators:

- `instanceof` returns a boolean to test if a value has a specific type.
- `typeof` returns the type of a field.

Example

Consider the following operations using `instanceof` and `typeof`:

- The following operation tests whether the `_id` field is of type `ObjectId`:

  ```
  mydoc._id instanceof ObjectId
  ```

  The operation returns `true`.

- The following operation returns the type of the `_id` field:

  ```
  typeof mydoc._id
  ```

  In this case `typeof` will return the more generic `object` type rather than `ObjectId` type.

Dot Notation

MongoDB uses the *dot notation* to access the elements of an array and to access the fields of a subdocument.

To access an element of an array by the zero-based index position, you concatenate the array name with the dot (`.`) and zero-based index position:

```
'<array>.<index>'
```

To access a field of a subdocument with *dot-notation*, you concatenate the subdocument name with the dot (`.`) and the field name:

```
'<subdocument>.<field>'
```

See Also:

- *Subdocuments* (page 113) for dot notation examples with subdocuments.
- *Arrays* (page 114) for dot notation examples with arrays.

16.2.2 Document Types in MongoDB

Record Documents

Most documents in MongoDB in *collections* store data from users' applications.

These documents have the following attributes:

- The maximum BSON document size is 16 megabytes.

  The maximum document size helps ensure that a single document cannot use excessive amount of RAM or, during transmission, excessive amount of bandwidth. To store documents larger than the maximum size, MongoDB provides the GridFS API. See `mongofiles` (page 942) and the documentation for your *driver* (page 435) for more information about GridFS.

- *Documents* (page 135) have the following restrictions on field names:

  - The field name `_id` is reserved for use as a primary key; its value must be unique in the collection, is immutable, and may be of any type other than an array.
  - The field names **cannot** start with the `$` character.
  - The field names **cannot** contain the `.` character.

Note: Most MongoDB driver clients will include the `_id` field and generate an `ObjectId` before sending the insert operation to MongoDB; however, if the client sends a document without an `_id` field, the `mongod` (page 897) will add the `_id` field and generate the `ObjectId`.

The following document specifies a record in a collection:

```
{
  _id: 1,
  name: { first: 'John', last: 'Backus' },
  birth: new Date('Dec 03, 1924'),
  death: new Date('Mar 17, 2007'),
  contribs: [ 'Fortran', 'ALGOL', 'Backus-Naur Form', 'FP' ],
  awards: [
            { award: 'National Medal of Science',
              year: 1975,
              by: 'National Science Foundation' },
            { award: 'Turing Award',
              year: 1977,
              by: 'ACM' }
          ]
}
```

The document contains the following fields:

- `_id`, which must hold a unique value and is *immutable*.
- `name` that holds another *document*. This sub-document contains the fields `first` and `last`, which both hold *strings*.
- `birth` and `death` that both have *date* types.
- `contribs` that holds an *array of strings*.
- `awards` that holds an *array of documents*.

Consider the following behavior and constraints of the `_id` field in MongoDB documents:

- In documents, the `_id` field is always indexed for regular collections.
- The `_id` field may contain values of any BSON data type other than an array.

Consider the following options for the value of an `_id` field:

- Use an `ObjectId`. See the *ObjectId* (page 142) documentation.

  Although it is common to assign `ObjectId` values to `_id` fields, if your objects have a natural unique identifier, consider using that for the value of `_id` to save space and to avoid an additional index.

- Generate a sequence number for the documents in your collection in your application and use this value for the `_id` value. See the *Create an Auto-Incrementing Sequence Field* (page 454) tutorial for an implementation pattern.

- Generate a UUID in your application code. For a more efficient storage of the UUID values in the collection and in the `_id` index, store the UUID as a value of the BSON `BinData` type.

  Index keys that are of the `BinData` type are more efficiently stored in the index if:

  - the binary subtype value is in the range of 0-7 or 128-135, and
  - the length of the byte array is: 0, 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 20, 24, or 32.

- Use your driver's BSON UUID facility to generate UUIDs. Be aware that driver implementations may implement UUID serialization and deserialization logic differently, which may not be fully compatible with other drivers. See your driver documentation for information concerning UUID interoperability.

Query Specification Documents

Query documents specify the conditions that determine which records to select for read, update, and delete operations. You can use `<field>:<value>` expressions to specify the equality condition and *query operator* (page 882) expressions to specify additional conditions.

When passed as an argument to methods such as the `find()` (page 820) method, the `remove()` (page 838) method, or the `update()` (page 842) method, the query document selects documents for MongoDB to return, remove, or update, as in the following:

```
db.bios.find( { _id: 1 } )
db.bios.remove( { _id: { $gt: 3 } } )
db.bios.update( { _id: 1, name: { first: 'John', last: 'Backus' } },
                <update>,
                <options> )
```

See Also:

- *Query Document* (page 112) and *Read* (page 159) for more examples on selecting documents for reads.
- *Update* (page 169) for more examples on selecting documents for updates.
- *Delete* (page 175) for more examples on selecting documents for deletes.

Update Specification Documents

Update documents specify the data modifications to perform during an `update()` (page 842) operation to modify existing records in a collection. You can use *update operators* (page 884) to specify the exact actions to perform on the document fields.

Consider the update document example:

```
{
  $set: { 'name.middle': 'Warner' },
  $push: { awards: { award: 'IBM Fellow',
                     year: '1963',
                     by: 'IBM' }
         }
}
```

When passed as an argument to the `update()` (page 842) method, the update actions document:

- Modifies the field `name` whose value is another document. Specifically, the `$set` (page 716) operator updates the `middle` field in the `name` subdocument. The document uses *dot notation* (page 137) to access a field in a subdocument.
- Adds an element to the field `awards` whose value is an array. Specifically, the `$push` (page 711) operator adds another document as element to the field `awards`.

```
db.bios.update(
   { _id: 1 },
   {
     $set: { 'name.middle': 'Warner' },
     $push: { awards: {
                      award: 'IBM Fellow',
```

```
                        year: '1963',
                        by: 'IBM'
                      }
            }
    }
)
```

See Also:

- *update operators* (page 884) page for the available update operators and syntax.
- *update* (page 169) for more examples on update documents.

For additional examples of updates that involve array elements, including where the elements are documents, see the `$` (page 710) positional operator.

Index Specification Documents

Index specification documents describe the fields to index on during the *index creation* (page 819). See *indexes* (page 241) for an overview of indexes. [2]

Index documents contain field and value pairs, in the following form:

```
{ field: value }
```

- `field` is the field in the documents to index.
- `value` is either 1 for ascending or -1 for descending.

The following document specifies the *multi-key index* (page 244) on the `_id` field and the `last` field contained in the subdocument `name` field. The document uses *dot notation* (page 137) to access a field in a subdocument:

```
{ _id: 1, 'name.last': 1 }
```

When passed as an argument to the `ensureIndex()` (page 819) method, the index documents specifies the index to create:

```
db.bios.ensureIndex( { _id: 1, 'name.last': 1 } )
```

Sort Order Specification Documents

Sort order documents specify the order of documents that a `query()` (page 820) returns. Pass sort order specification documents as an argument to the `sort()` (page 813) method. See the `sort()` (page 813) page for more information on sorting.

The sort order documents contain field and value pairs, in the following form:

```
{ field: value }
```

- `field` is the field by which to sort documents.
- `value` is either 1 for ascending or -1 for descending.

The following document specifies the sort order using the fields from a sub-document `name` first sort by the `last` field ascending, then by the `first` field also ascending:

```
{ 'name.last': 1, 'name.first': 1 }
```

[2] Indexes optimize a number of key *read* (page 111) and *write* (page 123) operations.

When passed as an argument to the sort() (page 813) method, the sort order document sorts the results of the find() (page 820) method:

```
db.bios.find().sort( { 'name.last': 1, 'name.first': 1 } )
```

16.2.3 BSON Type Considerations

The following BSON types require special consideration:

ObjectId

ObjectIds are: small, likely unique, fast to generate, and ordered. These values consists of 12-bytes, where the first 4-bytes is a timestamp that reflects the ObjectId's creation. Refer to the *ObjectId* (page 142) documentation for more information.

String

BSON strings are UTF-8. In general, drivers for each programming language convert from the language's string format to UTF-8 when serializing and deserializing BSON. This makes it possible to store most international characters in BSON strings with ease. [3] In addition, MongoDB $regex (page 713) queries support UTF-8 in the regex string.

Timestamps

BSON has a special timestamp type for *internal* MongoDB use and is **not** associated with the regular *Date* (page 142) type. Timestamp values are a 64 bit value where:

- the first 32 bits are a time_t value (seconds since the Unix epoch)
- the second 32 bits are an incrementing ordinal for operations within a given second.

Within a single mongod (page 897) instance, timestamp values are always unique.

In replication, the *oplog* has a ts field. The values in this field reflect the operation time, which uses a BSON timestamp value.

Note: The BSON Timestamp type is for *internal* MongoDB use. For most cases, in application development, you will want to use the BSON date type. See *Date* (page 142) for more information.

If you create a BSON Timestamp using the empty constructor (e.g. new Timestamp()), MongoDB will only generate a timestamp *if* you use the constructor in the first field of the document. [4] Otherwise, MongoDB will generate an empty timestamp value (i.e. Timestamp(0, 0).) Changed in version 2.1: mongo (page 908) shell displays the Timestamp value with the wrapper:

```
Timestamp(<time_t>, <ordinal>)
```

Prior to version 2.1, the mongo (page 908) shell display the Timestamp value as a document:

```
{ t : <time_t>, i : <ordinal> }
```

[3] Given strings using UTF-8 character sets, using sort() (page 813) on strings will be reasonably correct; however, because internally sort() (page 813) uses the C++ strcmp api, the sort order may handle some characters incorrectly.

[4] If the first field in the document is _id, then you can generate a timestamp in the *second* field of a document.

Date

BSON Date is a 64-bit integer that represents the number of milliseconds since the Unix epoch (Jan 1, 1970). The official BSON specification refers to the BSON Date type as the *UTC datetime*. Changed in version 2.0: BSON Date type is signed. [5] Negative values represent dates before 1970. Consider the following examples of BSON Date:

- Construct a Date using the `new Date()` constructor in the `mongo` (page 908) shell:

  ```
  var mydate1 = new Date()
  ```

- Construct a Date using the `ISODate()` constructor in the `mongo` (page 908) shell:

  ```
  var mydate2 = ISODate()
  ```

- Return the `Date` value as string:

  ```
  mydate1.toString()
  ```

- Return the month portion of the Date value; months are zero-indexed, so that January is month `0`:

  ```
  mydate1.getMonth()
  ```

16.3 ObjectId

16.3.1 Overview

ObjectId is a 12-byte *BSON* type, constructed using:

- a 4-byte timestamp,
- a 3-byte machine identifier,
- a 2-byte process id, and
- a 3-byte counter, starting with a random value.

In MongoDB, documents stored in a collection require a unique *_id* field that acts as a *primary key*. Because ObjectIds are small, most likely unique, and fast to generate, MongoDB uses ObjectIds as the default value for the `_id` field if the `_id` field is not specified; i.e., the `mongod` (page 897) adds the `_id` field and generates a unique ObjectId to assign as its value.

Using ObjectIds for the `_id` field, provides the following additional benefits:

- you can access the timestamp of the ObjectId's creation, using the `getTimestamp()` (page 801) method.
- sorting on an `_id` field that stores `ObjectId` values is roughly equivalent to sorting by creation time, although this relationship is not strict with `ObjectId` values generated on multiple systems within a single second.

Also consider the *BSON Documents* (page 135) section for related information on MongoDB's document orientation.

16.3.2 ObjectId()

The `mongo` (page 908) shell provides the `ObjectId()` wrapper class to generate a new ObjectId, and to provide the following helper attribute and methods:

[5] Prior to version 2.0, `Date` values were incorrectly interpreted as *unsigned* integers, which affected sorts, range queries, and indexes on `Date` fields. Because indexes are not recreated when upgrading, please re-index if you created an index on `Date` values with an earlier version, and dates before 1970 are relevant to your application.

- `str`

  The hexadecimal string value of the `ObjectId()` object.

- `getTimestamp()` (page 801)

  Returns the timestamp portion of the `ObjectId()` object as a Date.

- `toString()` (page 802)

  Returns the string representation of the `ObjectId()` object. The returned string literal has the format "`ObjectId(...)`". Changed in version 2.2: In previous versions `ObjectId.toString()` (page 802) returns the value of the ObjectId as a hexadecimal string.

- `valueOf()` (page 802)

  Returns the value of the `ObjectId()` object as a hexadecimal string. The returned string is the `str` attribute. Changed in version 2.2: In previous versions `ObjectId.valueOf()` (page 802) returns the `ObjectId()` object.

16.3.3 Examples

Consider the following uses `ObjectId()` class in the `mongo` (page 908) shell:

- To generate a new ObjectId, use the `ObjectId()` constructor with no argument:

  ```
  x = ObjectId()
  ```

  In this example, the value of `x` would be:

  ```
  ObjectId("507f1f77bcf86cd799439011")
  ```

- To generate a new ObjectId using the `ObjectId()` constructor with a unique hexadecimal string:

  ```
  y = ObjectId("507f191e810c19729de860ea")
  ```

  In this example, the value of `y` would be:

  ```
  ObjectId("507f191e810c19729de860ea")
  ```

- To return the timestamp of an `ObjectId()` object, use the `getTimestamp()` (page 801) method as follows:

  ```
  ObjectId("507f191e810c19729de860ea").getTimestamp()
  ```

  This operation will return the following Date object:

  ```
  ISODate("2012-10-17T20:46:22Z")
  ```

- Access the `str` attribute of an `ObjectId()` object, as follows:

  ```
  ObjectId("507f191e810c19729de860ea").str
  ```

  This operation will return the following hexadecimal string:

  ```
  507f191e810c19729de860ea
  ```

- To return the string representation of an `ObjectId()` object, use the `toString()` (page 802) method as follows:

  ```
  ObjectId("507f191e810c19729de860ea").toString()
  ```

  This operation will return the following output:

```
ObjectId("507f191e810c19729de860ea")
```

- To return the value of an `ObjectId()` object as a hexadecimal string, use the `valueOf()` (page 802) method as follows:

  ```
  ObjectId("507f191e810c19729de860ea").valueOf()
  ```

  This operation returns the following output:

  ```
  507f191e810c19729de860ea
  ```

16.4 Database References

MongoDB does not support joins. In MongoDB some data is *denormalized*, or stored with related data in *documents* to remove the need for joins. However, in some cases it makes sense to store related information in separate documents, typically in different collections or databases.

MongoDB applications use one of two methods for relating documents:

1. *Manual references* (page 144) where you save the `_id` field of one document in another document as a reference. Then your application can run a second query to return the embedded data. These references are simple and sufficient for most use cases.
2. *DBRefs* (page 145) are references from one document to another using the value of the first document's `_id` field collection, and optional database name. To resolve DBRefs, your application must perform additional queries to return the referenced documents. Many *drivers* (page 435) have helper methods that form the query for the DBRef automatically. The drivers [6] do not *automatically* resolve DBRefs into documents.

   Use a DBRef when you need to embed documents from multiple collections in documents from one collection. DBRefs also provide a common format and type to represent these relationships among documents. The DBRef format provides common semantics for representing links between documents if your database must interact with multiple frameworks and tools.

Unless you have a compelling reason for using a DBRef, use manual references.

16.4.1 Manual References

Background

Manual references refers to the practice of including one *document's* `_id` field in another document. The application can then issue a second query to resolve the referenced fields as needed.

Process

Consider the following operation to insert two documents, using the `_id` field of the first document as a reference in the second document:

```
original_id = ObjectId()

db.places.insert({
    "_id": original_id
    "name": "Broadway Center"
    "url": "bc.example.net"
```

[6] Some community supported drivers may have alternate behavior and may resolve a DBRef into a document automatically.

```
})

db.people.insert({
    "name": "Erin"
    "places_id": original_id
    "url":  "bc.example.net/Erin"
})
```

Then, when a query returns the document from the `people` collection you can, if needed, make a second query for the document referenced by the `places_id` field in the `places` collection.

Use

For nearly every case where you want to store a relationship between two documents, use *manual references* (page 144). The references are simple to create and your application can resolve references as needed.

The only limitation of manual linking is that these references do not convey the database and collection name. If you have documents in a single collection that relate to documents in more than one collection, you may need to consider using *DBRefs* (page 145).

16.4.2 DBRefs

Background

DBRefs are a convention for representing a *document*, rather than a specific reference "type." They include the name of the collection, and in some cases the database, in addition to the value from the `_id` field.

Format

DBRefs have the following fields:

`$ref`
: The `$ref` field holds the name of the collection where the referenced document resides.

`$id`
: The `$id` field contains the value of the `_id` field in the referenced document.

`$db`
: *Optional.*

  Contains the name of the database where the referenced document resides.

  Only some drivers support `$db` references.

Example

DBRef document would resemble the following:

```
{ "$ref" : <value>, "$id" : <value>, "$db" : <value> }
```

Consider a document from a collection that stored a DBRef in a `creator` field:

```
{
  "_id" : ObjectId("5126bbf64aed4daf9e2ab771"),
  // .. application fields
  "creator" : {
```

```
                "$ref" : "creators",
                "$id" : ObjectId("5126bc054aed4daf9e2ab772"),
                "$db" : "users"
            }
}
```

The DBRef in this example, points to a document in the `creators` collection of the `users` database that has `ObjectId("5126bc054aed4daf9e2ab772")` in its `_id` field.

Note: The order of fields in the DBRef matters, and you must use the above sequence when using a DBRef.

Support

C++ The C++ driver contains no support for DBRefs. You can transverse references manually.

C# The C# driver provides access to DBRef objects with the MongoDBRef Class and supplies the FetchDBRef Method for accessing these objects.

Java The DBRef class provides supports for DBRefs from Java.

JavaScript The `mongo` (page 908) shell's *JavaScript* (page 889) interface provides a DBRef.

Perl The Perl driver contains no support for DBRefs. You can transverse references manually or use the MongoDBx::AutoDeref CPAN module.

PHP The PHP driver does support DBRefs, including the optional `$db` reference, through The MongoDBRef class.

Python The Python driver provides the DBRef class, and the dereference method for interacting with DBRefs.

Ruby The Ruby Driver supports DBRefs using the DBRef class and the deference method.

Use

In most cases you should use the *manual reference* (page 144) method for connecting two or more related documents. However, if you need to reference documents from multiple collections, consider a DBRef.

16.5 GridFS

GridFS is a specification for storing and retrieving files that exceed the *BSON*-document *size limit* (page 1021) of 16MB.

Instead of storing a file in an single document, GridFS divides a file into parts, or chunks, [7] and stores each of those chunks as a separate document. By default GridFS limits chunk size to 256k. GridFS uses two collections to store files. One collection stores the file chunks, and the other stores file metadata.

When you query a GridFS store for a file, the driver or client will reassemble the chunks as needed. You can perform range queries on files stored through GridFS. You also can access information from arbitrary sections of files, which allows you to "skip" into the middle of a video or audio file.

GridFS is useful not only for storing files that exceed 16MB but also for storing any files for which you want access without having to load the entire file into memory. For more information on the indications of GridFS, see *When should I use GridFS?* (page 642).

[7] The use of the term *chunks* in the context of GridFS is not related to the use of the term *chunks* in the context of sharding.

16.5.1 Implement GridFS

To store and retrieve files using *GridFS*, use either of the following:

- A MongoDB driver. See the *drivers* (page 435) documentation for information on using GridFS with your driver.
- The `mongofiles` (page 942) command-line tool in the `mongo` (page 908) shell. See *mongofiles* (page 941).

16.5.2 GridFS Collections

GridFS stores files in two collections:

- `chunks` stores the binary chunks. For details, see *The chunks Collection* (page 147).
- `files` stores the file's metadata. For details, see *The files Collection* (page 147).

GridFS places the collections in a common bucket by prefixing each with the bucket name. By default, GridFS uses two collections with names prefixed by `fs` bucket:

- `fs.files`
- `fs.chunks`

You can choose a different bucket name than `fs`, and create multiple buckets in a single database.

The `chunks` Collection

Each document in the `chunks` collection represents a distinct chunk of a file as represented in the *GridFS* store. The following is a prototype document from the `chunks` collection.:

```
{
  "_id" : <string>,
  "files_id" : <string>,
  "n" : <num>,
  "data" : <binary>
}
```

A document from the `chunks` collection contains the following fields:

`chunks.`**`_id`**
: The unique *ObjectID* of the chunk.

`chunks.`**`files_id`**
: The `_id` of the "parent" document, as specified in the `files` collection.

`chunks.`**`n`**
: The sequence number of the chunk. GridFS numbers all chunks, starting with 0.

`chunks.`**`data`**
: The chunk's payload as a *BSON* binary type.

The `chunks` collection uses a *compound index* on `files_id` and `n`, as described in *GridFS Index* (page 148).

The `files` Collection

Each document in the `files` collection represents a file in the *GridFS* store. Consider the following prototype of a document in the `files` collection:

```
{
  "_id" : <ObjectID>,
  "length" : <num>,
  "chunkSize" : <num>
  "uploadDate" : <timestamp>
  "md5" : <hash>

  "filename" : <string>,
  "contentType" : <string>,
  "aliases" : <string array>,
  "metadata" : <dataObject>,
}
```

Documents in the `files` collection contain some or all of the following fields. Applications may create additional arbitrary fields:

`files._id`
: The unique ID for this document. The `_id` is of the data type you chose for the original document. The default type for MongoDB documents is *BSON ObjectID*.

`files.length`
: The size of the document in bytes.

`files.chunkSize`
: The size of each chunk. GridFS divides the document into chunks of the size specified here. The default size is 256 kilobytes.

`files.uploadDate`
: The date the document was first stored by GridFS. This value has the `Date` type.

`files.md5`
: An MD5 hash returned from the filemd5 API. This value has the `String` type.

`files.filename`
: Optional. A human-readable name for the document.

`files.contentType`
: Optional. A valid MIME type for the document.

`files.aliases`
: Optional. An array of alias strings.

`files.metadata`
: Optional. Any additional information you want to store.

16.5.3 GridFS Index

GridFS uses a *unique*, *compound* index on the `chunks` collection for `files_id` and `n`. The index allows efficient retrieval of chunks using the `files_id` and `n` values, as shown in the following example:

```
cursor = db.fs.chunks.find({files_id: myFileID}).sort({n:1});
```

See the relevant *driver* (page 435) documentation for the specific behavior of your GridFS application. If your driver does not create this index, issue the following operation using the `mongo` (page 908) shell:

```
db.fs.chunks.ensureIndex( { files_id: 1, n: 1 }, { unique: true } );
```

16.5.4 Example Interface

The following is an example of the GridFS interface in Java. The example is for demonstration purposes only. For API specifics, see the relevant *driver* (page 435) documentation.

By default, the interface must support the default GridFS bucket, named `fs`, as in the following:

```
GridFS myFS = new GridFS(myDatabase); // returns default GridFS bucket (e.g. "fs"  collection)
myFS.storeFile(new File("/tmp/largething.mpg")); // saves the file to "fs" GridFS bucket
```

Optionally, interfaces may support other additional GridFS buckets as in the following example:

```
GridFS myContracts = new GridFS(myDatabase, "contracts"); // returns GridFS bucket named "contracts"
myFS.retrieveFile("smithco", new File("/tmp/smithco.pdf")); // retrieve GridFS object "smithco"
```

CHAPTER 17

CRUD Operations for MongoDB

These documents provide an overview and examples of common database operations, i.e. CRUD, in MongoDB.

17.1 Create

Of the four basic database operations (i.e. CRUD), *create* operations are those that add new records or *documents* to a *collection* in MongoDB. For general information about write operations and the factors that affect their performance, see *Write Operations* (page 123); for documentation of the other CRUD operations, see the *Core MongoDB Operations (CRUD)* (page 109) page.

- Overview (page 151)
- `insert()` (page 152)
  - Insert the First Document in a Collection (page 152)
  - Insert a Document without Specifying an `_id` Field (page 153)
  - Bulk Insert Multiple Documents (page 155)
  - Insert a Document with `save()` (page 156)
- `update()` Operations with the `upsert` Flag (page 157)
  - Insert a Document that Contains `field` and `value` Pairs (page 157)
  - Insert a Document that Contains Update Operator Expressions (page 158)
  - Update operations with with `save()` (page 159)

17.1.1 Overview

You can create documents in a MongoDB collection using any of the following basic operations:

- *insert* (page 152)
- *updates with the upsert option* (page 157)

All insert operations in MongoDB exhibit the following properties:

- If you attempt to insert a document without the *_id* field, the client library *or* the `mongod` (page 897) instance will add an `_id` field and populate the field with a unique *ObjectId*.
- For operations with *write concern* (page 124), if you specify an `_id` field, the `_id` field must be unique within the collection; otherwise the `mongod` (page 897) will return a duplicate key exception.

- The maximum BSON document size is 16 megabytes.

  The maximum document size helps ensure that a single document cannot use excessive amount of RAM or, during transmission, excessive amount of bandwidth. To store documents larger than the maximum size, MongoDB provides the GridFS API. See `mongofiles` (page 942) and the documentation for your *driver* (page 435) for more information about GridFS.

- *Documents* (page 135) have the following restrictions on field names:
  - The field name `_id` is reserved for use as a primary key; its value must be unique in the collection, is immutable, and may be of any type other than an array.
  - The field names **cannot** start with the `$` character.
  - The field names **cannot** contain the `.` character.

Note: As of these *driver versions* (page 1062), all write operations will issue a `getLastError` (page 766) command to confirm the result of the write operation:

```
{ getLastError: 1 }
```

Refer to the documentation on *write concern* (page 124) in the *Write Operations* (page 123) document for more information.

17.1.2 `insert()`

The `insert()` (page 830) is the primary method to insert a document or documents into a MongoDB collection, and has the following syntax:

```
db.collection.insert( <document> )
```

Corresponding Operation in SQL

The `insert()` (page 830) method is analogous to the `INSERT` statement.

Insert the First Document in a Collection

If the collection does not exist [1], then the `insert()` (page 830) method creates the collection during the first insert. Specifically in the example, if the collection `bios` does not exist , then the insert operation will create this collection:

```
db.bios.insert(
   {
     _id: 1,
     name: { first: 'John', last: 'Backus' },
     birth: new Date('Dec 03, 1924'),
     death: new Date('Mar 17, 2007'),
     contribs: [ 'Fortran', 'ALGOL', 'Backus-Naur Form', 'FP' ],
     awards: [
               {
                 award: 'W.W. McDowell Award',
                 year: 1967,
                 by: 'IEEE Computer Society'
               },
               {
```

[1] You can also view a list of the existing collections in the database using the `show collections` operation in the `mongo` (page 908) shell.

```
                award: 'National Medal of Science',
                year: 1975,
                by: 'National Science Foundation'
              },
              {
                award: 'Turing Award',
                year: 1977,
                by: 'ACM'
              },
              {
                award: 'Draper Prize',
                year: 1993,
                by: 'National Academy of Engineering'
              }
            ]
   }
)
```

You can confirm the insert by *querying* (page 159) the `bios` collection:

```
db.bios.find()
```

This operation returns the following document from the `bios` collection:

```
{
  "_id" : 1,
  "name" : { "first" : "John", "last" : "Backus" },
  "birth" : ISODate("1924-12-03T05:00:00Z"),
  "death" : ISODate("2007-03-17T04:00:00Z"),
  "contribs" : [ "Fortran", "ALGOL", "Backus-Naur Form", "FP" ],
  "awards" : [
              {
                "award" : "W.W. McDowell Award",
                "year" : 1967,
                "by" : "IEEE Computer Society"
              },
              {
                "award" : "National Medal of Science",
                "year" : 1975,
                "by" : "National Science Foundation"
              },
              {
                "award" : "Turing Award",
                "year" : 1977,
                "by" : "ACM"
              },
              { "award" : "Draper Prize",
                "year" : 1993,
                "by" : "National Academy of Engineering"
              }
            ]
}
```

Insert a Document without Specifying an `_id` Field

If the new document does not contain an `_id` field, then the `insert()` (page 830) method adds the `_id` field to the document and generates a unique `ObjectId` for the value:

```
db.bios.insert(
   {
     name: { first: 'John', last: 'McCarthy' },
     birth: new Date('Sep 04, 1927'),
     death: new Date('Dec 24, 2011'),
     contribs: [ 'Lisp', 'Artificial Intelligence', 'ALGOL' ],
     awards: [
                {
                  award: 'Turing Award',
                  year: 1971,
                  by: 'ACM'
                },
                {
                  award: 'Kyoto Prize',
                  year: 1988,
                  by: 'Inamori Foundation'
                },
                {
                  award: 'National Medal of Science',
                  year: 1990,
                  by: 'National Science Foundation'
                }
              ]
   }
)
```

You can verify the inserted document by the querying the `bios` collection:

```
db.bios.find( { name: { first: 'John', last: 'McCarthy' } } )
```

The returned document contains an `_id` field with the generated `ObjectId` value:

```
{
  "_id" : ObjectId("50a1880488d113a4ae94a94a"),
  "name" : { "first" : "John", "last" : "McCarthy" },
  "birth" : ISODate("1927-09-04T04:00:00Z"),
  "death" : ISODate("2011-12-24T05:00:00Z"),
  "contribs" : [ "Lisp", "Artificial Intelligence", "ALGOL" ],
  "awards" : [
                {
                  "award" : "Turing Award",
                  "year" : 1971,
                  "by" : "ACM"
                },
                {
                  "award" : "Kyoto Prize",
                  "year" :1988,
                  "by" : "Inamori Foundation"
                },
                {
                  "award" : "National Medal of Science",
                  "year" : 1990,
                  "by" : "National Science Foundation"
                }
              ]
}
```

Bulk Insert Multiple Documents

If you pass an array of documents to the `insert()` (page 830) method, the `insert()` (page 830) performs a bulk insert into a collection.

The following operation inserts three documents into the `bios` collection. The operation also illustrates the *dynamic schema* characteristic of MongoDB. Although the document with `_id: 3` contains a field `title` which does not appear in the other documents, MongoDB does not require the other documents to contain this field:

```
db.bios.insert(
   [
     {
       _id: 3,
       name: { first: 'Grace', last: 'Hopper' },
       title: 'Rear Admiral',
       birth: new Date('Dec 09, 1906'),
       death: new Date('Jan 01, 1992'),
       contribs: [ 'UNIVAC', 'compiler', 'FLOW-MATIC', 'COBOL' ],
       awards: [
                 {
                   award: 'Computer Sciences Man of the Year',
                   year: 1969,
                   by: 'Data Processing Management Association'
                 },
                 {
                   award: 'Distinguished Fellow',
                   year: 1973,
                   by: ' British Computer Society'
                 },
                 {
                   award: 'W. W. McDowell Award',
                   year: 1976,
                   by: 'IEEE Computer Society'
                 },
                 {
                   award: 'National Medal of Technology',
                   year: 1991,
                   by: 'United States'
                 }
               ]
     },
     {
       _id: 4,
       name: { first: 'Kristen', last: 'Nygaard' },
       birth: new Date('Aug 27, 1926'),
       death: new Date('Aug 10, 2002'),
       contribs: [ 'OOP', 'Simula' ],
       awards: [
                 {
                   award: 'Rosing Prize',
                   year: 1999,
                   by: 'Norwegian Data Association'
                 },
                 {
                   award: 'Turing Award',
                   year: 2001,
                   by: 'ACM'
                 },
                 {
```

```
                award: 'IEEE John von Neumann Medal',
                year: 2001,
                by: 'IEEE'
              }
            ]
    },
    {
      _id: 5,
      name: { first: 'Ole-Johan', last: 'Dahl' },
      birth: new Date('Oct 12, 1931'),
      death: new Date('Jun 29, 2002'),
      contribs: [ 'OOP', 'Simula' ],
      awards: [
                {
                award: 'Rosing Prize',
                year: 1999,
                by: 'Norwegian Data Association'
                },
                {
                award: 'Turing Award',
                year: 2001,
                by: 'ACM'
                },
                {
                award: 'IEEE John von Neumann Medal',
                year: 2001,
                by: 'IEEE'
                }
            ]
    }
  ]
)
```

Insert a Document with `save()`

The `save()` (page 840) method performs an insert if the document to save does not contain the `_id` field.

The following `save()` (page 840) operation performs an insert into the `bios` collection since the document does not contain the `_id` field:

```
db.bios.save(
   {
        name: { first: 'Guido', last: 'van Rossum'},
        birth: new Date('Jan 31, 1956'),
        contribs: [ 'Python' ],
        awards: [
                {
                award: 'Award for the Advancement of Free Software',
                year: 2001,
                by: 'Free Software Foundation'
                },
                {
                award: 'NLUUG Award',
                year: 2003,
                by: 'NLUUG'
                }
            ]
```

```
    }
)
```

17.1.3 `update()` Operations with the `upsert` Flag

The `update()` (page 842) operation in MongoDB accepts an "`upsert`" flag that modifies the behavior of `update()` (page 842) from *updating existing documents* (page 169), to inserting data.

These `update()` (page 842) operations with the upsert flag eliminate the need to perform an additional operation to check for existence of a record before performing either an update or an insert operation. These update operations have the use `<query>` argument to determine the write operation:

- If the query matches an existing document(s), the operation is an *update* (page 169).
- If the query matches no document in the collection, the operation is an *insert* (page 151).

An upsert operation has the following syntax [2]:

```
db.collection.update( <query>,
                      <update>,
                      { upsert: true } )
```

Insert a Document that Contains `field` and `value` Pairs

If no document matches the `<query>` argument, the `upsert` performs an insert. If the `<update>` argument includes only field and value pairs, the new document contains the fields and values specified in the `<update>` argument. If query does not include an `_id` field, the operation adds the `_id` field and generates a unique `ObjectId` for its value.

The following update inserts a new document into the `bios` collection [2]:

```
db.bios.update(
   { name: { first: 'Dennis', last: 'Ritchie'} },
   {
     name: { first: 'Dennis', last: 'Ritchie'},
     birth: new Date('Sep 09, 1941'),
     death: new Date('Oct 12, 2011'),
     contribs: [ 'UNIX', 'C' ],
     awards: [
               {
                 award: 'Turing Award',
                 year: 1983,
                 by: 'ACM'
               },
               {
                 award: 'National Medal of Technology',
                 year: 1998,
                 by: 'United States'
               },
               {
                 award: 'Japan Prize',
                 year: 2011,
                 by: 'The Japan Prize Foundation'
               }
```

[2] Prior to version 2.2, in the `mongo` (page 908) shell, you would specify the `upsert` and the `multi` options in the `update()` (page 842) method as positional boolean options. See `update()` (page 842) for details.

```
            ]
    },
    { upsert: true }
)
```

Insert a Document that Contains Update Operator Expressions

If no document matches the `<query>` argument, the update operation inserts a new document. If the `<update>` argument includes only *update operators* (page 884), the new document contains the fields and values from `<query>` argument with the operations from the `<update>` argument applied.

The following operation inserts a new document into the `bios` collection [2]:

```
db.bios.update(
    {
      _id: 7,
      name: { first: 'Ken', last: 'Thompson' }
    },
    {
      $set: {
              birth: new Date('Feb 04, 1943'),
              contribs: [ 'UNIX', 'C', 'B', 'UTF-8' ],
              awards: [
                        {
                          award: 'Turing Award',
                          year: 1983,
                          by: 'ACM'
                        },
                        {
                          award: 'IEEE Richard W. Hamming Medal',
                          year: 1990,
                          by: 'IEEE'
                        },
                        {
                          award: 'National Medal of Technology',
                          year: 1998,
                          by: 'United States'
                        },
                        {
                          award: 'Tsutomu Kanai Award',
                          year: 1999,
                          by: 'IEEE'
                        },
                        {
                          award: 'Japan Prize',
                          year: 2011,
                          by: 'The Japan Prize Foundation'
                        }
                      ]
            }
    },
    { upsert: true }
)
```

Update operations with with `save()`

The `save()` (page 840) method is identical to an *update operation with the upsert flag* (page 157)

performs an upsert if the document to save contains the `_id` field. To determine whether to perform an insert or an update, `save()` (page 840) method queries documents on the `_id` field.

The following operation performs an upsert that inserts a document into the `bios` collection since no documents in the collection contains an `_id` field with the value `10`:

```
db.bios.save(
   {
     _id: 10,
     name: { first: 'Yukihiro', aka: 'Matz', last: 'Matsumoto'},
     birth: new Date('Apr 14, 1965'),
     contribs: [ 'Ruby' ],
     awards: [
               {
                 award: 'Award for the Advancement of Free Software',
                 year: '2011',
                 by: 'Free Software Foundation'
               }
             ]
   }
)
```

17.2 Read

Of the four basic database operations (i.e. CRUD), read operations are those that retrieve records or *documents* from a *collection* in MongoDB. For general information about read operations and the factors that affect their performance, see *Read Operations* (page 111); for documentation of the other CRUD operations, see the *Core MongoDB Operations (CRUD)* (page 109) page.

- Overview (page 160)
- `find()` (page 160)
  - Return All Documents in a Collection (page 161)
  - Return Documents that Match Query Conditions (page 162)
    - Equality Matches (page 162)
    - Using Operators (page 162)
    - On Arrays (page 162)
      - Query an Element (page 162)
      - Query Multiple Fields on an Array of Documents (page 162)
    - On Subdocuments (page 163)
      - Exact Matches (page 163)
      - Fields of a Subdocument (page 163)
    - Logical Operators (page 163)
      - `OR` Disjunctions (page 163)
      - `AND` Conjunctions (page 164)
  - With a Projection (page 164)
    - Specify the Fields to Return (page 164)
    - Explicitly Exclude the `_id` Field (page 164)
    - Return All but the Excluded Fields (page 165)
    - On Arrays and Subdocuments (page 165)
  - Iterate the Returned Cursor (page 165)
    - With Variable Name (page 166)
    - With `next()` Method (page 166)
    - With `forEach()` Method (page 166)
  - Modify the Cursor Behavior (page 166)
    - Order Documents in the Result Set (page 167)
    - Limit the Number of Documents to Return (page 167)
    - Set the Starting Point of the Result Set (page 167)
    - Combine Cursor Methods (page 167)
- `findOne()` (page 167)
  - With Empty Query Specification (page 168)
  - With a Query Specification (page 168)
  - With a Projection (page 168)
    - Specify the Fields to Return (page 168)
    - Return All but the Excluded Fields (page 168)
  - Access the `findOne` Result (page 169)

17.2.1 Overview

You can retrieve documents from MongoDB using either of the following methods:

- *find* (page 160)
- *findOne* (page 167)

17.2.2 `find()`

The `find()` (page 820) method is the primary method to select documents from a collection. The `find()` (page 820) method returns a cursor that contains a number of documents. Most *drivers* (page 435) provide application developers with a native iterable interface for handling cursors and accessing documents. The `find()` (page 820) method has the following syntax:

```
db.collection.find( <query>, <projection> )
```

Corresponding Operation in SQL

The `find()` (page 820) method is analogous to the `SELECT` statement, while:

- the `<query>` argument corresponds to the `WHERE` statement, and
- the `<projection>` argument corresponds to the list of fields to select from the result set.

The examples refer to a collection named `bios` that contains documents with the following prototype:

```
{
  "_id" : 1,
  "name" : {
             "first" : "John",
             "last" :"Backus"
           },
  "birth" : ISODate("1924-12-03T05:00:00Z"),
  "death" : ISODate("2007-03-17T04:00:00Z"),
  "contribs" : [ "Fortran", "ALGOL", "Backus-Naur Form", "FP" ],
  "awards" : [
              {
                "award" : "W.W. McDowellAward",
                "year" : 1967,
                "by" : "IEEE Computer Society"
              },
              {
                "award" : "National Medal of Science",
                "year" : 1975,
                "by" : "National Science Foundation"
              },
              {
                "award" : "Turing Award",
                "year" : 1977,
                "by" : "ACM"
              },
              {
                "award" : "Draper Prize",
                "year" : 1993,
                "by" : "National Academy of Engineering"
              }
  ]
}
```

Note: In the `mongo` (page 908) shell, you can format the output by adding `.pretty()` to the `find()` (page 820) method call.

Return All Documents in a Collection

If there is no `<query>` argument, the :method:‘ ~db.collection.find()‘ method selects all documents from a collection.

The following operation returns all documents (or more precisely, a cursor to all documents) in the `bios` collection:

```
db.bios.find()
```

Return Documents that Match Query Conditions

If there is a <query> argument, the `find()` (page 820) method selects all documents from a collection that satisfies the query specification.

Equality Matches

The following operation returns a cursor to documents in the `bios` collection where the field `_id` equals `5`:

```
db.bios.find(
   {
      _id: 5
   }
)
```

Using Operators

The following operation returns a cursor to all documents in the `bios` collection where the field `_id` equals `5` or `ObjectId("507c35dd8fada716c89d0013")`:

```
db.bios.find(
   {
      _id: { $in: [ 5,  ObjectId("507c35dd8fada716c89d0013") ] }
   }
)
```

On Arrays

Query an Element The following operation returns a cursor to all documents in the `bios` collection where the array field `contribs` contains the element `'UNIX'`:

```
db.bios.find(
   {
     contribs: 'UNIX'
   }
)
```

Query Multiple Fields on an Array of Documents The following operation returns a cursor to all documents in the `bios` collection where `awards` array contains a subdocument element that contains the `award` field equal to `'Turing Award'` and the `year` field greater than 1980:

```
db.bios.find(
   {
      awards: {
                $elemMatch: {
                     award: 'Turing Award',
                     year: { $gt: 1980 }
                }
      }
   }
)
```

On Subdocuments

Exact Matches The following operation returns a cursor to all documents in the `bios` collection where the subdocument `name` is *exactly* `{ first: 'Yukihiro', last: 'Matsumoto' }`, including the order:

```
db.bios.find(
    {
      name: {
              first: 'Yukihiro',
              last: 'Matsumoto'
            }
    }
)
```

The `name` field must match the sub-document exactly, including order. For instance, the query would **not** match documents with `name` fields that held either of the following values:

```
{
   first: 'Yukihiro',
   aka: 'Matz',
   last: 'Matsumoto'
}

{
   last: 'Matsumoto',
   first: 'Yukihiro'
}
```

Fields of a Subdocument The following operation returns a cursor to all documents in the `bios` collection where the subdocument `name` contains a field `first` with the value `'Yukihiro'` and a field `last` with the value `'Matsumoto'`; the query uses *dot notation* to access fields in a subdocument:

```
db.bios.find(
   {
     'name.first': 'Yukihiro',
     'name.last': 'Matsumoto'
   }
)
```

The query matches the document where the `name` field contains a subdocument with the field `first` with the value `'Yukihiro'` and a field `last` with the value `'Matsumoto'`. For instance, the query would match documents with `name` fields that held either of the following values:

```
{
  first: 'Yukihiro',
  aka: 'Matz',
  last: 'Matsumoto'
}

{
  last: 'Matsumoto',
  first: 'Yukihiro'
}
```

Logical Operators

OR Disjunctions The following operation returns a cursor to all documents in the `bios` collection where either the field `first` in the sub-document `name` starts with the letter `G` **or** where the field `birth` is less than `new Date('01/01/1945')`:

```
db.bios.find(
   { $or: [
            { 'name.first' : /^G/ },
            { birth: { $lt: new Date('01/01/1945') } }
          ]
   }
)
```

AND Conjunctions The following operation returns a cursor to all documents in the `bios` collection where the field `first` in the subdocument `name` starts with the letter `K` **and** the array field `contribs` contains the element `UNIX`:

```
db.bios.find(
   {
      'name.first': /^K/,
      contribs: 'UNIX'
   }
)
```

In this query, the parameters (i.e. the selections of both fields) combine using an implicit logical AND for criteria on different fields `contribs` and `name.first`. For multiple `AND` criteria on the same field, use the `$and` (page 692) operator.

With a Projection

If there is a `<projection>` argument, the `find()` (page 820) method returns only those fields as specified in the `<projection>` argument to include or exclude:

Note: The `_id` field is implicitly included in the `<projection>` argument. In projections that explicitly include fields, `_id` is the only field that you can explicitly exclude. Otherwise, you cannot mix include field and exclude field specifications.

Specify the Fields to Return

The following operation finds all documents in the `bios` collection and returns only the `name` field, the `contribs` field, and the `_id` field:

```
db.bios.find(
    { },
    { name: 1, contribs: 1 }
 )
```

Explicitly Exclude the `_id` Field

The following operation finds all documents in the `bios` collection and returns only the `name` field and the `contribs` field:

```
db.bios.find(
   { },
   { name: 1, contribs: 1, _id: 0 }
)
```

Return All but the Excluded Fields

The following operation finds the documents in the `bios` collection where the `contribs` field contains the element `'OOP'` and returns all fields *except* the `_id` field, the `first` field in the `name` subdocument, and the `birth` field from the matching documents:

```
db.bios.find(
   { contribs: 'OOP' },
   { _id: 0, 'name.first': 0, birth: 0 }
)
```

On Arrays and Subdocuments

The following operation finds all documents in the `bios` collection and returns the the `last` field in the `name` subdocument and the first two elements in the `contribs` array:

```
db.bios.find(
   { },
   {
     _id: 0,
     'name.last': 1,
     contribs: { $slice: 2 }
   }
)
```

See Also:

- *dot notation* for information on "reaching into" embedded sub-documents.
- *Arrays* (page 114) for more examples on accessing arrays.
- *Subdocuments* (page 113) for more examples on accessing subdocuments.
- `$elemMatch` (page 695) query operator for more information on matching array elements.
- `$elemMatch` projection operator for additional information on restricting array elements to return.

Iterate the Returned Cursor

The `find()` (page 820) method returns a *cursor* to the results; however, in the `mongo` (page 908) shell, if the returned cursor is not assigned to a variable, then the cursor is automatically iterated up to 20 times [3] to print up to the first 20 documents that match the query, as in the following example:

```
db.bios.find( { _id: 1 } );
```

[3] You can use the `DBQuery.shellBatchSize` to change the number of iteration from the default value `20`. See *Cursor Flags* (page 122) and *Cursor Behaviors* (page 121) for more information.

With Variable Name

When you assign the `find()` (page 820) to a variable, you can type the name of the cursor variable to iterate up to 20 times [1] and print the matching documents, as in the following example:

```
var myCursor = db.bios.find( { _id: 1 } );

myCursor
```

With `next()` Method

You can use the cursor method `next()` (page 811) to access the documents, as in the following example:

```
var myCursor = db.bios.find( { _id: 1 } );

var myDocument = myCursor.hasNext() ? myCursor.next() : null;

if (myDocument) {
    var myName = myDocument.name;
    print (tojson(myName));
}
```

To print, you can also use the `printjson()` method instead of `print(tojson())`:

```
if (myDocument) {
   var myName = myDocument.name;
   printjson(myName);
}
```

With `forEach()` Method

You can use the cursor method `forEach()` (page 806) to iterate the cursor and access the documents, as in the following example:

```
var myCursor = db.bios.find( { _id: 1 } );

myCursor.forEach(printjson);
```

For more information on cursor handling, see:

- `cursor.hasNext()` (page 806)
- `cursor.next()` (page 811)
- `cursor.forEach()` (page 806)
- *cursors* (page 119)
- *JavaScript cursor methods* (page 890)

Modify the Cursor Behavior

In addition to the `<query>` and the `<projection>` arguments, the `mongo` (page 908) shell and the *drivers* (page 435) provide several cursor methods that you can call on the *cursor* returned by `find()` (page 820) method to modify its behavior, such as:

Order Documents in the Result Set

The `sort()` (page 813) method orders the documents in the result set.

The following operation returns all documents (or more precisely, a cursor to all documents) in the `bios` collection ordered by the `name` field ascending:

```
db.bios.find().sort( { name: 1 } )
```

`sort()` (page 813) corresponds to the `ORDER BY` statement in SQL.

Limit the Number of Documents to Return

The `limit()` (page 807) method limits the number of documents in the result set.

The following operation returns at most `5` documents (or more precisely, a cursor to at most 5 documents) in the `bios` collection:

```
db.bios.find().limit( 5 )
```

`limit()` (page 807) corresponds to the `LIMIT` statement in SQL.

Set the Starting Point of the Result Set

The `skip()` (page 812) method controls the starting point of the results set.

The following operation returns all documents, skipping the first `5` documents in the `bios` collection:

```
db.bios.find().skip( 5 )
```

Combine Cursor Methods

You can chain these cursor methods, as in the following examples [4]:

```
db.bios.find().sort( { name: 1 } ).limit( 5 )
db.bios.find().limit( 5 ).sort( { name: 1 } )
```

See the *JavaScript cursor methods* (page 890) reference and your *driver* (page 435) documentation for additional references. See *Cursors* (page 119) for more information regarding cursors.

17.2.3 `findOne()`

The `findOne()` (page 825) method selects a single document from a collection and returns that document. `findOne()` (page 825) does *not* return a cursor.

The `findOne()` (page 825) method has the following syntax:

```
db.collection.findOne( <query>, <projection> )
```

Except for the return value, `findOne()` (page 825) method is quite similar to the `find()` (page 820) method; in fact, internally, the `findOne()` (page 825) method is the `find()` (page 820) method with a limit of 1.

[4] Regardless of the order you chain the `limit()` (page 807) and the `sort()` (page 813), the request to the server has the structure that treats the query and the :method:‘ ~cursor.sort()‘ modifier as a single object. Therefore, the `limit()` (page 807) operation method is always applied after the `sort()` (page 813) regardless of the specified order of the operations in the chain. See the *meta query operators* (page 885) for more information.

With Empty Query Specification

If there is no <query> argument, the findOne() (page 825) method selects just one document from a collection.

The following operation returns a single document from the bios collection:

```
db.bios.findOne()
```

With a Query Specification

If there is a <query> argument, the findOne() (page 825) method selects the first document from a collection that meets the <query> argument:

The following operation returns the first matching document from the bios collection where either the field first in the subdocument name starts with the letter G **or** where the field birth is less than new Date('01/01/1945'):

```
db.bios.findOne(
   {
     $or: [
            { 'name.first' : /^G/ },
            { birth: { $lt: new Date('01/01/1945') } }
          ]
   }
)
```

With a Projection

You can pass a <projection> argument to findOne() (page 825) to control the fields included in the result set.

Specify the Fields to Return

The following operation finds a document in the bios collection and returns only the name field, the contribs field, and the _id field:

```
db.bios.findOne(
    { },
    { name: 1, contribs: 1 }
)
```

Return All but the Excluded Fields

The following operation returns a document in the bios collection where the contribs field contains the element OOP and returns all fields *except* the _id field, the first field in the name subdocument, and the birth field from the matching documents:

```
db.bios.findOne(
   { contribs: 'OOP' },
   { _id: 0, 'name.first': 0, birth: 0 }
)
```

Access the `findOne` Result

Although similar to the `find()` (page 820) method, because the `findOne()` (page 825) method returns a document rather than a cursor, you cannot apply the cursor methods such as `limit()` (page 807), `sort()` (page 813), and `skip()` (page 812) to the result of the `findOne()` (page 825) method. However, you can access the document directly, as in the example:

```
var myDocument = db.bios.findOne();

if (myDocument) {
   var myName = myDocument.name;

   print (tojson(myName));
}
```

17.3 Update

Of the four basic database operations (i.e. CRUD), *update* operations are those that modify existing records or *documents* in a MongoDB *collection*. For general information about write operations and the factors that affect their performance, see *Write Operations* (page 123); for documentation of other CRUD operations, see the *Core MongoDB Operations (CRUD)* (page 109) page.

- Overview (page 169)
- Update (page 170)
  - Modify with Update Operators (page 170)
    - Update a Field in a Document (page 170)
    - Add a New Field to a Document (page 171)
    - Remove a Field from a Document (page 171)
    - Update Arrays (page 171)
      - Update an Element by Specifying Its Position (page 171)
      - Update an Element without Specifying Its Position (page 171)
      - Update a Document Element without Specifying Its Position (page 172)
      - Add an Element to an Array (page 172)
    - Update Multiple Documents (page 172)
  - Replace Existing Document with New Document (page 172)
- `update()` Operations with the `upsert` Flag (page 173)
- Save (page 174)
  - Behavior (page 174)
  - Save Performs an Update (page 174)
- Update Operators (page 175)
  - Fields (page 175)
  - Array (page 175)
  - Bitwise (page 175)
  - Isolation (page 175)

17.3.1 Overview

Update operation modifies an existing *document* or documents in a *collection*. MongoDB provides the following methods to perform update operations:

- *update* (page 170)

- *save* (page 174)

Note: Consider the following behaviors of MongoDB's update operations.

- When performing update operations that increase the document size beyond the allocated space for that document, the update operation relocates the document on disk and may reorder the document fields depending on the type of update.
- As of these *driver versions* (page 1062), all write operations will issue a `getLastError` (page 766) command to confirm the result of the write operation:

  ```
  { getLastError: 1 }
  ```

  Refer to the documentation on *write concern* (page 124) in the *Write Operations* (page 123) document for more information.

17.3.2 Update

The `update()` (page 842) method is the primary method used to modify documents in a MongoDB collection. By default, the `update()` (page 842) method updates a **single** document, but by using the `multi` option, `update()` (page 842) can update all documents that match the query criteria in the collection. The `update()` (page 842) method can either replace the existing document with the new document or update specific fields in the existing document.

The `update()` (page 842) has the following syntax [5]:

```
db.collection.update( <query>, <update>, <options> )
```

Corresponding operation in SQL

The `update()` (page 842) method corresponds to the `UPDATE` operation in SQL, and:

- the `<query>` argument corresponds to the `WHERE` statement, and
- the `<update>` corresponds to the `SET ...` statement.

The default behavior of the `update()` (page 842) method updates a **single** document and would correspond to the SQL `UPDATE` statement with the `LIMIT 1`. With the `multi` option, `update()` (page 842) method would correspond to the SQL `UPDATE` statement without the `LIMIT` clause.

Modify with Update Operators

If the `<update>` argument contains only *update operator* (page 175) expressions such as the `$set` (page 716) operator expression, the `update()` (page 842) method updates the corresponding fields in the document. To update fields in subdocuments, MongoDB uses *dot notation*.

Update a Field in a Document

Use `$set` (page 716) to update a value of a field.

The following operation queries the `bios` collection for the first document that has an `_id` field equal to `1` and sets the value of the field `middle`, in the subdocument `name`, to `Warner`:

[5] This examples uses the interface added in MongoDB 2.2 to specify the `multi` and the `upsert` options in a document form. .. include:: /includes/fact-upsert-multi-options.rst

```
db.bios.update(
   { _id: 1 },
   {
     $set: { 'name.middle': 'Warner' },
   }
)
```

Add a New Field to a Document

If the <update> argument contains fields not currently in the document, the update() (page 842) method adds the new fields to the document.

The following operation queries the bios collection for the first document that has an _id field equal to 3 and adds to that document a new mbranch field and a new aka field in the subdocument name:

```
db.bios.update(
   { _id: 3 },
   { $set: {
             mbranch: 'Navy',
             'name.aka': 'Amazing Grace'
           }
   }
)
```

Remove a Field from a Document

If the <update> argument contains $unset (page 720) operator, the update() (page 842) method removes the field from the document.

The following operation queries the bios collection for the first document that has an _id field equal to 3 and removes the birth field from the document:

```
db.bios.update(
   { _id: 3 },
   { $unset: { birth: 1 } }
)
```

Update Arrays

Update an Element by Specifying Its Position If the update operation requires an update of an element in an array field, the update() (page 842) method can perform the update using the position of the element and *dot notation*. Arrays in MongoDB are zero-based.

The following operation queries the bios collection for the first document with _id field equal to 1 and updates the second element in the contribs array:

```
db.bios.update(
   { _id: 1 },
   { $set: { 'contribs.1': 'ALGOL 58' } }
)
```

Update an Element without Specifying Its Position The update() (page 842) method can perform the update using the $ (page 710) positional operator if the position is not known. The array field must appear in the query argument in order to determine which array element to update.

The following operation queries the bios collection for the first document where the _id field equals 3 and the contribs array contains an element equal to compiler. If found, the update() (page 842) method updates the first matching element in the array to A compiler in the document:

```
db.bios.update(
       { _id: 3, 'contribs': 'compiler' },
       { $set: { 'contribs.$': 'A compiler' } }
    )
```

Update a Document Element without Specifying Its Position The update() (page 842) method can perform the update of an array that contains subdocuments by using the positional operator (i.e. $ (page 710)) and the *dot notation*.

The following operation queries the bios collection for the first document where the _id field equals 6 and the awards array contains a subdocument element with the by field equal to ACM. If found, the update() (page 842) method updates the by field in the first matching subdocument:

```
db.bios.update(
   { _id: 6, 'awards.by': 'ACM'   } ,
   { $set: { 'awards.$.by': 'Association for Computing Machinery' } }
)
```

Add an Element to an Array The following operation queries the bios collection for the first document that has an _id field equal to 1 and adds a new element to the awards field:

```
db.bios.update(
   { _id: 1 },
   {
     $push: { awards: { award: 'IBM Fellow', year: 1963, by: 'IBM' } }
   }
)
```

Update Multiple Documents

If the <options> argument contains the multi option set to true or 1, the update() (page 842) method updates all documents that match the query.

The following operation queries the bios collection for all documents where the awards field contains a subdocument element with the award field equal to Turing and sets the turing field to true in the matching documents [6]:

```
db.bios.update(
   { 'awards.award': 'Turing' },
   { $set: { turing: true } },
   { multi: true }
)
```

Replace Existing Document with New Document

If the <update> argument contains only field and value pairs, the update() (page 842) method *replaces* the existing document with the document in the <update> argument, except for the _id field.

[6] Prior to version 2.2, in the mongo (page 908) shell, you would specify the upsert and the multi options in the update() (page 842) method as positional boolean options. See update() (page 842) for details.

The following operation queries the `bios` collection for the first document that has a `name` field equal to `{ first: 'John', last: 'McCarthy' }` and replaces all but the `_id` field in the document with the fields in the `<update>` argument:

```
db.bios.update(
   { name: { first: 'John', last: 'McCarthy' } },
   { name: { first: 'Ken', last: 'Iverson' },
     born: new Date('Dec 17, 1941'),
     died: new Date('Oct 19, 2004'),
     contribs: [ 'APL', 'J' ],
     awards: [
               { award: 'Turing Award',
                 year: 1979,
                 by: 'ACM' },
               { award: 'Harry H. Goode Memorial Award',
                 year: 1975,
                 by: 'IEEE Computer Society' },
               { award: 'IBM Fellow',
                 year: 1970,
                 by: 'IBM' }
             ]
   }
)
```

17.3.3 `update()` Operations with the `upsert` Flag

If you set the `upsert` option in the `<options>` argument to `true` or `1` and no existing document match the `<query>` argument, the `update()` (page 842) method can insert a new document into the collection. [7]

The following operation queries the `bios` collection for a document with the `_id` field equal to `11` and the `name` field equal to `{ first: 'James', last: 'Gosling'}`. If the query selects a document, the operation performs an update operation. If a document is not found, `update()` (page 842) inserts a new document containing the fields and values from `<query>` argument with the operations from the `<update>` argument applied. [8]

```
db.bios.update(
   { _id:11, name: { first: 'James', last: 'Gosling' } },
   {
     $set: {
             born: new Date('May 19, 1955'),
             contribs: [ 'Java' ],
             awards: [
                       {
                         award: 'The Economist Innovation Award',
                         year: 2002,
                         by: 'The Economist'
                       },
                       {
                         award: 'Officer of the Order of Canada',
                         year: 2007,
                         by: 'Canada'
                       }
                     ]
```

[7] Prior to version 2.2, in the `mongo` (page 908) shell, you would specify the `upsert` and the `multi` options in the `update()` (page 842) method as positional boolean options. See `update()` (page 842) for details.

[8] If the `<update>` argument includes only field and value pairs, the new document contains the fields and values specified in the `<update>` argument. If the `<update>` argument includes only *update operators* (page 175), the new document contains the fields and values from `<query>` argument with the operations from the `<update>` argument applied.

```
            }
    },
    { upsert: true }
)
```

See also *Update Operations with the Upsert Flag* (page 157) in the *Create* (page 151) document.

17.3.4 Save

The `save()` (page 840) method performs a special type of `update()` (page 842), depending on the `_id` field of the specified document.

The `save()` (page 840) method has the following syntax:

```
db.collection.save( <document> )
```

Behavior

If you specify a document with an `_id` field, `save()` (page 840) performs an `update()` (page 842) with the `upsert` option set: if an existing document in the collection has the same `_id`, `save()` (page 840) updates that document, and inserts the document otherwise. If you do not specify a document with an `_id` field to `save()` (page 840), performs an `insert()` (page 830) operation.

That is, `save()` (page 840) method is equivalent to the `update()` (page 842) method with the `upsert` option and a `<query>` argument with an `_id` field.

Example

Consider the following psudocode explanation of `save()` (page 840) as an illustration of its behavior:

```
function save( doc ) {
  if( doc["_id"] ) {
       update( {_id: doc["_id"] }, doc, { upsert: true } );
    }
  else {
       insert(doc);
  }
}
```

Save Performs an Update

If the `<document>` argument contains the `_id` field that exists in the collection, the `save()` (page 840) method performs an update that replaces the existing document with the `<document>` argument.

The following operation queries the `bios` collection for a document where the `_id` equals `ObjectId("507c4e138fada716c89d0014")` and replaces the document with the `<document>` argument:

```
db.bios.save(
   {
     _id: ObjectId("507c4e138fada716c89d0014"),
     name: { first: 'Martin', last: 'Odersky' },
     contribs: [ 'Scala' ]
```

```
    }
)
```

See Also:

Insert a Document with save() (page 156) and *Update operations with with save()* (page 159) in the *Create* (page 151) section.

17.3.5 Update Operators

Fields

- `$inc` (page 699)
- `$rename` (page 714)
- `$set` (page 716)
- `$unset` (page 720)

Array

- `$` (page 710)
- `$addToSet` (page 691)
- `$pop` (page 709)
- `$pullAll` (page 711)
- `$pull` (page 711)
- `$pushAll` (page 712)
- `$push` (page 711)

Bitwise

- `$bit` (page 693)

Isolation

- `$isolated` (page 699)

17.4 Delete

Of the four basic database operations (i.e. CRUD), *delete* operations are those that remove documents from a *collection* in MongoDB.

For general information about write operations and the factors that affect their performance, see *Write Operations* (page 123); for documentation of other CRUD operations, see the *Core MongoDB Operations (CRUD)* (page 109) page.

- Overview (page 176)
- Remove All Documents that Match a Condition (page 176)
- Remove a Single Document that Matches a Condition (page 177)
- Remove All Documents from a Collection (page 177)
- Capped Collection (page 177)
- Isolation (page 177)

17.4.1 Overview

The *remove()* (page 176) method in the `mongo` (page 908) shell provides this operation, as do corresponding methods in the *drivers* (page 435).

Note: As of these *driver versions* (page 1062), all write operations will issue a `getLastError` (page 766) command to confirm the result of the write operation:

```
{ getLastError: 1 }
```

Refer to the documentation on *write concern* (page 124) in the *Write Operations* (page 123) document for more information.

Use the `remove()` (page 838) method to delete documents from a collection. The `remove()` (page 838) method has the following syntax:

```
db.collection.remove( <query>, <justOne> )
```

Corresponding operation in SQL

The `remove()` (page 838) method is analogous to the `DELETE` statement, and:

- the `<query>` argument corresponds to the `WHERE` statement, and
- the `<justOne>` argument takes a Boolean and has the same affect as `LIMIT 1`.

`remove()` (page 838) deletes documents from the collection. If you do not specify a query, `remove()` (page 838) removes all documents from a collection, but does not remove the indexes. [9]

Note: For large deletion operations, it may be more efficient to copy the documents that you want to keep to a new collection and then use `drop()` (page 818) on the original collection.

17.4.2 Remove All Documents that Match a Condition

If there is a `<query>` argument, the `remove()` (page 838) method deletes from the collection all documents that match the argument.

The following operation deletes all documents from the `bios` collection where the subdocument `name` contains a field `first` whose value starts with `G`:

[9] To remove all documents from a collection, it may be more efficient to use the `drop()` (page 818) method to drop the entire collection, including the indexes, and then recreate the collection and rebuild the indexes.

```
db.bios.remove( { 'name.first' : /^G/ } )
```

17.4.3 Remove a Single Document that Matches a Condition

If there is a <query> argument and you specify the <justOne> argument as true or 1, remove() (page 838) only deletes a single document from the collection that matches the query.

The following operation deletes a single document from the bios collection where the turing field equals true:

```
db.bios.remove( { turing: true }, 1 )
```

17.4.4 Remove All Documents from a Collection

If there is no <query> argument, the remove() (page 838) method deletes all documents from a collection. The following operation deletes all documents from the bios collection:

```
db.bios.remove()
```

Note: This operation is not equivalent to the drop() (page 818) method.

17.4.5 Capped Collection

You cannot use the remove() (page 838) method with a *capped collection*.

17.4.6 Isolation

If the <query> argument to the remove() (page 838) method matches multiple documents in the collection, the delete operation may interleave with other write operations to that collection. For an unsharded collection, you have the option to override this behavior with the $isolated (page 699) isolation operator, effectively isolating the delete operation from other write operations. To isolate the operation, include $isolated: 1 in the <query> parameter as in the following example:

```
db.bios.remove( { turing: true, $isolated: 1 } )
```

CHAPTER 18

Data Modeling Patterns

18.1 Model Embedded One-to-One Relationships Between Documents

18.1.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that uses *embedded* (page 132) documents to describe relationships between connected data.

18.1.2 Pattern

Consider the following example that maps patron and address relationships. The example illustrates the advantage of embedding over referencing if you need to view one data entity in context of the other. In this one-to-one relationship between `patron` and `address` data, the `address` belongs to the `patron`.

In the normalized data model, the `address` contains a reference to the `parent`.

```
{
   _id: "joe",
   name: "Joe Bookreader"
}

{
   patron_id: "joe",
   street: "123 Fake Street",
   city: "Faketon",
   state: "MA"
   zip: 12345
}
```

If the `address` data is frequently retrieved with the `name` information, then with referencing, your application needs to issue multiple queries to resolve the reference. The better data model would be to embed the `address` data in the `patron` data, as in the following document:

```
{
   _id: "joe",
   name: "Joe Bookreader",
   address: {
              street: "123 Fake Street",
              city: "Faketon",
              state: "MA"
              zip: 12345
            }
}
```

With the embedded data model, your application can retrieve the complete patron information with one query.

18.2 Model Embedded One-to-Many Relationships Between Documents

18.2.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that uses *embedded* (page 132) documents to describe relationships between connected data.

18.2.2 Pattern

Consider the following example that maps patron and multiple address relationships. The example illustrates the advantage of embedding over referencing if you need to view many data entities in context of another. In this one-to-many relationship between `patron` and `address` data, the `patron` has multiple `address` entities.

In the normalized data model, the `address` contains a reference to the `parent`.

```
{
   _id: "joe",
   name: "Joe Bookreader"
}

{
   patron_id: "joe",
   street: "123 Fake Street",
   city: "Faketon",
   state: "MA",
   zip: 12345
}

{
   patron_id: "joe",
   street: "1 Some Other Street",
   city: "Boston",
   state: "MA",
   zip: 12345
}
```

If your application frequently retrieves the `address` data with the `name` information, then your application needs to issue multiple queries to resolve the references. A more optimal schema would be to embed the `address` data entities in the `patron` data, as in the following document:

```
{
   _id: "joe",
   name: "Joe Bookreader",
   addresses: [
                 {
                   street: "123 Fake Street",
                   city: "Faketon",
                   state: "MA",
                   zip: 12345
                 },
                 {
                   street: "1 Some Other Street",
                   city: "Boston",
                   state: "MA",
                   zip: 12345
                 }
               ]
 }
```

With the embedded data model, your application can retrieve the complete patron information with one query.

18.3 Model Referenced One-to-Many Relationships Between Documents

18.3.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that uses *references* (page 132) between documents to describe relationships between connected data.

18.3.2 Pattern

Consider the following example that maps publisher and book relationships. The example illustrates the advantage of referencing over embedding to avoid repetition of the publisher information.

Embedding the publisher document inside the book document would lead to **repetition** of the publisher data, as the following documents show:

```
{
   title: "MongoDB: The Definitive Guide",
   author: [ "Kristina Chodorow", "Mike Dirolf" ],
   published_date: ISODate("2010-09-24"),
   pages: 216,
   language: "English",
   publisher: {
              name: "O'Reilly Media",
              founded: 1980,
              location: "CA"
```

```
            }
}

{
   title: "50 Tips and Tricks for MongoDB Developer",
   author: "Kristina Chodorow",
   published_date: ISODate("2011-05-06"),
   pages: 68,
   language: "English",
   publisher: {
              name: "O'Reilly Media",
              founded: 1980,
              location: "CA"
            }
}
```

To avoid repetition of the publisher data, use *references* and keep the publisher information in a separate collection from the book collection.

When using references, the growth of the relationships determine where to store the reference. If the number of books per publisher is small with limited growth, storing the book reference inside the publisher document may sometimes be useful. Otherwise, if the number of books per publisher is unbounded, this data model would lead to mutable, growing arrays, as in the following example:

```
{
   name: "O'Reilly Media",
   founded: 1980,
   location: "CA",
   books: [12346789, 234567890, ...]
}

{
    _id: 123456789,
    title: "MongoDB: The Definitive Guide",
    author: [ "Kristina Chodorow", "Mike Dirolf" ],
    published_date: ISODate("2010-09-24"),
    pages: 216,
    language: "English"
}

{
   _id: 234567890,
   title: "50 Tips and Tricks for MongoDB Developer",
   author: "Kristina Chodorow",
   published_date: ISODate("2011-05-06"),
   pages: 68,
   language: "English"
}
```

To avoid mutable, growing arrays, store the publisher reference inside the book document:

```
{
   _id: "oreilly",
   name: "O'Reilly Media",
   founded: 1980,
   location: "CA"
}

{
```

```
   _id: 123456789,
   title: "MongoDB: The Definitive Guide",
   author: [ "Kristina Chodorow", "Mike Dirolf" ],
   published_date: ISODate("2010-09-24"),
   pages: 216,
   language: "English",
   publisher_id: "oreilly"
}

{
   _id: 234567890,
   title: "50 Tips and Tricks for MongoDB Developer",
   author: "Kristina Chodorow",
   published_date: ISODate("2011-05-06"),
   pages: 68,
   language: "English",
   publisher_id: "oreilly"
}
```

18.4 Model Data for Atomic Operations

18.4.1 Pattern

Consider the following example that keeps a library book and its checkout information. The example illustrates how embedding fields related to an atomic update within the same document ensures that the fields are in sync.

Consider the following `book` document that stores the number of available copies for checkout and the current checkout information:

```
book = {
          _id: 123456789,
          title: "MongoDB: The Definitive Guide",
          author: [ "Kristina Chodorow", "Mike Dirolf" ],
          published_date: ISODate("2010-09-24"),
          pages: 216,
          language: "English",
          publisher_id: "oreilly",
          available: 3,
          checkout: [ { by: "joe", date: ISODate("2012-10-15") } ]
        }
```

You can use the `db.collection.findAndModify()` (page 822) method to atomically determine if a book is available for checkout and update with the new checkout information. Embedding the `available` field and the `checkout` field within the same document ensures that the updates to these fields are in sync:

```
db.books.findAndModify ( {
   query: {
             _id: 123456789,
             available: { $gt: 0 }
           },
   update: {
             $inc: { available: -1 },
             $push: { checkout: { by: "abc", date: new Date() } }
            }
} )
```

18.5 Model Tree Structures with Parent References

18.5.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that describes a tree-like structure in MongoDB documents by storing *references* (page 132) to "parent" nodes in children nodes.

18.5.2 Pattern

The *Parent References* pattern stores each tree node in a document; in addition to the tree node, the document stores the id of the node's parent.

Consider the following example that models a tree of categories using *Parent References*:

```
db.categories.insert( { _id: "MongoDB", parent: "Databases" } )
db.categories.insert( { _id: "Postgres", parent: "Databases" } )
db.categories.insert( { _id: "Databases", parent: "Programming" } )
db.categories.insert( { _id: "Languages", parent: "Programming" } )
db.categories.insert( { _id: "Programming", parent: "Books" } )
db.categories.insert( { _id: "Books", parent: null } )
```

- The query to retrieve the parent of a node is fast and straightforward:

  ```
  db.categories.findOne( { _id: "MongoDB" } ).parent
  ```

- You can create an index on the field `parent` to enable fast search by the parent node:

  ```
  db.categories.ensureIndex( { parent: 1 } )
  ```

- You can query by the `parent` field to find its immediate children nodes:

  ```
  db.categories.find( { parent: "Databases" } )
  ```

The *Parent Links* pattern provides a simple solution to tree storage, but requires multiple queries to retrieve subtrees.

18.6 Model Tree Structures with Child References

18.6.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that describes a tree-like structure in MongoDB documents by storing *references* (page 132) in the parent-nodes to children nodes.

18.6.2 Pattern

The *Child References* pattern stores each tree node in a document; in addition to the tree node, document stores in an array the id(s) of the node's children.

Consider the following example that models a tree of categories using *Child References*:

```
db.categories.insert( { _id: "MongoDB", children: [] } )
db.categories.insert( { _id: "Postgres", children: [] } )
db.categories.insert( { _id: "Databases", children: [ "MongoDB", "Postgres" ] } )
db.categories.insert( { _id: "Languages", children: [] } )
db.categories.insert( { _id: "Programming", children: [ "Databases", "Languages" ] } )
db.categories.insert( { _id: "Books", children: [ "Programming" ] } )
```

- The query to retrieve the immediate children of a node is fast and straightforward:

  ```
  db.categories.findOne( { _id: "Databases" } ).children
  ```

- You can create an index on the field `children` to enable fast search by the child nodes:

  ```
  db.categories.ensureIndex( { children: 1 } )
  ```

- You can query for a node in the `children` field to find its parent node as well as its siblings:

  ```
  db.categories.find( { children: "MongoDB" } )
  ```

The *Child References* pattern provides a suitable solution to tree storage as long as no operations on subtrees are necessary. This pattern may also provide a suitable solution for storing graphs where a node may have multiple parents.

18.7 Model Tree Structures with an Array of Ancestors

18.7.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that describes a tree-like structure in MongoDB documents using *references* (page 132) to parent nodes and an array that stores all ancestors.

18.7.2 Pattern

The *Array of Ancestors* pattern stores each tree node in a document; in addition to the tree node, document stores in an array the id(s) of the node's ancestors or path.

Consider the following example that models a tree of categories using *Array of Ancestors*:

```
db.categories.insert( { _id: "MongoDB", ancestors: [ "Books", "Programming", "Databases" ], parent: "
db.categories.insert( { _id: "Postgres", ancestors: [ "Books", "Programming", "Databases" ], parent:
db.categories.insert( { _id: "Databases", ancestors: [ "Books", "Programming" ], parent: "Programming
db.categories.insert( { _id: "Languages", ancestors: [ "Books", "Programming" ], parent: "Programming
db.categories.insert( { _id: "Programming", ancestors: [ "Books" ], parent: "Books" } )
db.categories.insert( { _id: "Books", ancestors: [ ], parent: null } )
```

- The query to retrieve the ancestors or path of a node is fast and straightforward:

  ```
  db.categories.findOne( { _id: "MongoDB" } ).ancestors
  ```

- You can create an index on the field `ancestors` to enable fast search by the ancestors nodes:

```
db.categories.ensureIndex( { ancestors: 1 } )
```

- You can query by the `ancestors` to find all its descendants:

```
db.categories.find( { ancestors: "Programming" } )
```

The *Array of Ancestors* pattern provides a fast and efficient solution to find the descendants and the ancestors of a node by creating an index on the elements of the ancestors field. This makes *Array of Ancestors* a good choice for working with subtrees.

The *Array of Ancestors* pattern is slightly slower than the *Materialized Paths* pattern but is more straightforward to use.

18.8 Model Tree Structures with Materialized Paths

18.8.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that describes a tree-like structure in MongoDB documents by storing full relationship paths between documents.

18.8.2 Pattern

The *Materialized Paths* pattern stores each tree node in a document; in addition to the tree node, document stores as a string the id(s) of the node's ancestors or path. Although the *Materialized Paths* pattern requires additional steps of working with strings and regular expressions, the pattern also provides more flexibility in working with the path, such as finding nodes by partial paths.

Consider the following example that models a tree of categories using *Materialized Paths* ; the path string uses the comma `,` as a delimiter:

```
db.categories.insert( { _id: "Books", path: null } )
db.categories.insert( { _id: "Programming", path: ",Books," } )
db.categories.insert( { _id: "Databases", path: ",Books,Programming," } )
db.categories.insert( { _id: "Languages", path: ",Books,Programming," } )
db.categories.insert( { _id: "MongoDB", path: ",Books,Programming,Databases," } )
db.categories.insert( { _id: "Postgres", path: ",Books,Programming,Databases," } )
```

- You can query to retrieve the whole tree, sorting by the `path`:

```
db.categories.find().sort( { path: 1 } )
```

- You can use regular expressions on the `path` field to find the descendants of `Programming`:

```
db.categories.find( { path: /,Programming,/ } )
```

- You can also retrieve the descendants of `Books` where the `Books` is also at the topmost level of the hierarchy:

```
db.categories.find( { path: /^,Books,/ } )
```

- To create an index on the field `path` use the following invocation:

```
db.categories.ensureIndex( { path: 1 } )
```

This index may improve performance, depending on the query:

- For queries of the `Books` sub-tree (e.g. `http://docs.mongodb.org/v2.2/^,Books,/`) an index on the `path` field improves the query performance significantly.
- For queries of the `Programming` sub-tree (e.g. `http://docs.mongodb.org/v2.2/,Programming,/`), or similar queries of sub-tress, where the node might be in the middle of the indexed string, the query must inspect the entire index.

  For these queries an index *may* provide some performance improvement *if* the index is significantly smaller than the entire collection.

18.9 Model Tree Structures with Nested Sets

18.9.1 Overview

Data in MongoDB has a *flexible schema*. *Collections* do not enforce *document* structure. Decisions that affect how you model data can affect application performance and database capacity. See *Data Modeling Considerations for MongoDB Applications* (page 131) for a full high level overview of data modeling in MongoDB.

This document describes a data model that describes a tree like structure that optimizes discovering subtrees at the expense of tree mutability.

18.9.2 Pattern

The *Nested Sets* pattern identifies each node in the tree as stops in a round-trip traversal of the tree. The application visits each node in the tree twice; first during the initial trip, and second during the return trip. The *Nested Sets* pattern stores each tree node in a document; in addition to the tree node, document stores the id of node's parent, the node's initial stop in the `left` field, and its return stop in the `right` field.

Consider the following example that models a tree of categories using *Nested Sets*:

```
db.categories.insert( { _id: "Books", parent: 0, left: 1, right: 12 } )
db.categories.insert( { _id: "Programming", parent: "Books", left: 2, right: 11 } )
db.categories.insert( { _id: "Languages", parent: "Programming", left: 3, right: 4 } )
db.categories.insert( { _id: "Databases", parent: "Programming", left: 5, right: 10 } )
db.categories.insert( { _id: "MongoDB", parent: "Databases", left: 6, right: 7 } )
db.categories.insert( { _id: "Postgres", parent: "Databases", left: 8, right: 9 } )
```

You can query to retrieve the descendants of a node:

```
var databaseCategory = db.v.findOne( { _id: "Databases" } );
db.categories.find( { left: { $gt: databaseCategory.left }, right: { $lt: databaseCategory.right } } )
```

The *Nested Sets* pattern provides a fast and efficient solution for finding subtrees but is inefficient for modifying the tree structure. As such, this pattern is best for static trees that do not change.

18.10 Model Data to Support Keyword Search

If your application needs to perform queries on the content of a field that holds text you can perform exact matches on the text or use `$regex` (page 713) to use regular expression pattern matches. However, for many operations on text, these methods do not satisfy application requirements.

This pattern describes one method for supporting keyword search using MongoDB to support application search functionality, that uses keywords stored in an array in the same document as the text field. Combined with a *multi-key index* (page 244), this pattern can support application's keyword search operations.

Note: Keyword search is *not* the same as text search or full text search, and does not provide stemming or other text-processing features. See the *Limitations of Keyword Indexes* (page 188) section for more information.

18.10.1 Pattern

To add structures to your document to support keyword-based queries, create an array field in your documents and add the keywords as strings in the array. You can then create a *multi-key index* (page 244) on the array and create queries that select values from the array.

Example

Suppose you have a collection of library volumes that you want to make searchable by topics. For each volume, you add the array `topics`, and you add as many keywords as needed for a given volume.

For the `Moby-Dick` volume you might have the following document:

```
{ title : "Moby-Dick" ,
  author : "Herman Melville" ,
  published : 1851 ,
  ISBN : 0451526996 ,
  topics : [ "whaling" , "allegory" , "revenge" , "American" ,
    "novel" , "nautical" , "voyage" , "Cape Cod" ]
}
```

You then create a multi-key index on the `topics` array:

```
db.volumes.ensureIndex( { topics: 1 } )
```

The multi-key index creates separate index entries for each keyword in the `topics` array. For example the index contains one entry for `whaling` and another for `allegory`.

You then query based on the keywords. For example:

```
db.volumes.findOne( { topics : "voyage" }, { title: 1 } )
```

Note: An array with a large number of elements, such as one with several hundreds or thousands of keywords will incur greater indexing costs on insertion.

18.10.2 Limitations of Keyword Indexes

MongoDB can support keyword searches using specific data models and *multi-key indexes* (page 244); however, these keyword indexes are not sufficient or comparable to full-text products in the following respects:

- *Stemming*. Keyword queries in MongoDB can not parse keywords for root or related words.
- *Synonyms*. Keyword-based search features must provide support for synonym or related queries in the application layer.
- *Ranking*. The keyword look ups described in this document do not provide a way to weight results.

- *Asynchronous Indexing*. MongoDB builds indexes synchronously, which means that the indexes used for keyword indexes are always current and can operate in real-time. However, asynchronous bulk indexes may be more efficient for some kinds of content and workloads.

Part V

Aggregation

In version 2.2, MongoDB introduced the *aggregation framework* (page 195) that provides a powerful and flexible set of tools to use for many data aggregation tasks. If you're familiar with data aggregation in SQL, consider the *SQL to Aggregation Framework Mapping Chart* (page 879) document as an introduction to some of the basic concepts in the aggregation framework. Consider the full documentation of the aggregation framework here:

CHAPTER 19

Aggregation Framework

New in version 2.1.

19.1 Overview

The MongoDB aggregation framework provides a means to calculate aggregated values without having to use *map-reduce*. While map-reduce is powerful, it is often more difficult than necessary for many simple aggregation tasks, such as totaling or averaging field values.

If you're familiar with *SQL*, the aggregation framework provides similar functionality to `GROUP BY` and related SQL operators as well as simple forms of "self joins." Additionally, the aggregation framework provides projection capabilities to reshape the returned data. Using the projections in the aggregation framework, you can add computed fields, create new virtual sub-objects, and extract sub-fields into the top-level of results.

See Also:

A presentation from MongoSV 2011: MongoDB's New Aggregation Framework.

Additionally, consider *Aggregation Framework Examples* (page 201) and *Aggregation Framework Reference* (page 211) for more documentation.

19.2 Framework Components

This section provides an introduction to the two concepts that underpin the aggregation framework: *pipelines* and *expressions*.

19.2.1 Pipelines

Conceptually, documents from a collection pass through an aggregation pipeline, which transforms these objects as they pass through. For those familiar with UNIX-like shells (e.g. bash,) the concept is analogous to the pipe (i.e. `|`) used to string text filters together.

In a shell environment the pipe redirects a stream of characters from the output of one process to the input of the next. The MongoDB aggregation pipeline streams MongoDB documents from one *pipeline operator* (page 212) to the next to process the documents. Pipeline operators can be repeated in the pipe.

All pipeline operators process a stream of documents and the pipeline behaves as if the operation scans a *collection* and passes all matching documents into the "top" of the pipeline. Each operator in the pipeline transforms each document as it passes through the pipeline.

Note: Pipeline operators need not produce one output document for every input document: operators may also generate new documents or filter out documents.

Warning: The pipeline cannot operate on values of the following types: `Binary`, `Symbol`, `MinKey`, `MaxKey`, `DBRef`, `Code`, and `CodeWScope`.

See Also:

The "*Aggregation Framework Reference* (page 211)" includes documentation of the following pipeline operators:

- `$project` (page 733)
- `$match` (page 731)
- `$limit` (page 730)
- `$skip` (page 735)
- `$unwind`
- `$group`
- `$sort` (page 735)

19.2.2 Expressions

Expressions (page 218) produce output documents based on calculations performed on input documents. The aggregation framework defines expressions using a document format using prefixes.

Expressions are stateless and are only evaluated when seen by the aggregation process. All aggregation expressions can only operate on the current document in the pipeline, and cannot integrate data from other documents.

The *accumulator* expressions used in the `$group` operator maintain that state (e.g. totals, maximums, minimums, and related data) as documents progress through the *pipeline*.

See Also:

Aggregation expressions (page 218) for additional examples of the expressions provided by the aggregation framework.

19.3 Use

19.3.1 Invocation

Invoke an *aggregation* operation with the `aggregate()` (page 815) wrapper in the `mongo` (page 908) shell or the `aggregate` (page 740) *database command*. Always call `aggregate()` (page 815) on a collection object that determines the input documents of the aggregation *pipeline*. The arguments to the `aggregate()` (page 815) method specify a sequence of *pipeline operators* (page 212), where each operator may have a number of operands.

First, consider a *collection* of documents named `articles` using the following format:

```
{
 title : "this is my title" ,
 author : "bob" ,
 posted : new Date () ,
 pageViews : 5 ,
 tags : [ "fun" , "good" , "fun" ] ,
 comments : [
             { author :"joe" , text : "this is cool" } ,
             { author :"sam" , text : "this is bad" }
 ],
 other : { foo : 5 }
}
```

The following example aggregation operation pivots data to create a set of author names grouped by tags applied to an article. Call the aggregation framework by issuing the following command:

```
db.articles.aggregate(
  { $project : {
     author : 1,
     tags : 1,
  } },
  { $unwind : "$tags" },
  { $group : {
     _id : { tags : "$tags" },
     authors : { $addToSet : "$author" }
  } }
);
```

The aggregation pipeline begins with the *collection* `articles` and selects the `author` and `tags` fields using the `$project` (page 733) aggregation operator. The `$unwind` operator produces one output document per tag. Finally, the `$group` operator pivots these fields.

19.3.2 Result

The aggregation operation in the previous section returns a *document* with two fields:

- `result` which holds an array of documents returned by the *pipeline*
- `ok` which holds the value `1`, indicating success, or another value if there was an error

As a document, the result is subject to the *BSON Document size* (page 1021) limit, which is currently 16 megabytes.

19.4 Optimizing Performance

Because you will always call `aggregate` (page 740) on a *collection* object, which logically inserts the *entire* collection into the aggregation pipeline, you may want to optimize the operation by avoiding scanning the entire collection whenever possible.

19.4.1 Pipeline Operators and Indexes

Depending on the order in which they appear in the pipeline, aggregation operators can take advantage of indexes.

The following pipeline operators take advantage of an index when they occur at the beginning of the pipeline:

- `$match` (page 731)

- $sort (page 735)
- $limit (page 730)
- $skip (page 735).

The above operators can also use an index when placed **before** the following aggregation operators:

- $project (page 733)
- $unwind
- $group (page 728).

19.4.2 Early Filtering

If your aggregation operation requires only a subset of the data in a collection, use the $match (page 731) operator to restrict which items go in to the top of the pipeline, as in a query. When placed early in a pipeline, these $match (page 731) operations use suitable indexes to scan only the matching documents in a collection.

Placing a $match (page 731) pipeline stage followed by a $sort (page 735) stage at the start of the pipeline is logically equivalent to a single query with a sort, and can use an index.

In future versions there may be an optimization phase in the pipeline that reorders the operations to increase performance without affecting the result. However, at this time place $match (page 731) operators at the beginning of the pipeline when possible.

19.4.3 Memory for Cumulative Operators

Certain pipeline operators require access to the entire input set before they can produce any output. For example, $sort (page 735) must receive all of the input from the preceding *pipeline* operator before it can produce its first output document. The current implementation of $sort (page 735) does not go to disk in these cases: in order to sort the contents of the pipeline, the entire input must fit in memory.

$group (page 728) has similar characteristics: Before any $group (page 728) passes its output along the pipeline, it must operator, this frequently does not require as much memory as $sort (page 735), because it only needs to retain one record for each unique key in the grouping specification.

The current implementation of the aggregation framework logs a warning if a cumulative operator consumes 5% or more of the physical memory on the host. Cumulative operators produce an error if they consume 10% or more of the physical memory on the host.

19.5 Sharded Operation

Note: Changed in version 2.1. Some aggregation operations using aggregate (page 740) will cause mongos (page 905) instances to require more CPU resources than in previous versions. This modified performance profile may dictate alternate architectural decisions if you use the *aggregation framework* extensively in a sharded environment.

The aggregation framework is compatible with sharded collections.

When operating on a sharded collection, the aggregation pipeline splits into two parts. The aggregation framework pushes all of the operators up to the first $group (page 728) or $sort (page 735) operation to each shard. [1] Then,

[1] If an early $match (page 731) can exclude shards through the use of the shard key in the predicate, then these operators are only pushed to the relevant shards.

a second pipeline on the mongos (page 905) runs. This pipeline consists of the first $group (page 728) or $sort (page 735) and any remaining pipeline operators, and runs on the results received from the shards.

The $group (page 728) operator brings in any "sub-totals" from the shards and combines them: in some cases these may be structures. For example, the $avg expression maintains a total and count for each shard; mongos (page 905) combines these values and then divides.

19.6 Limitations

Aggregation operations with the aggregate (page 740) command have the following limitations:

- The pipeline cannot operate on values of the following types: Binary, Symbol, MinKey, MaxKey, DBRef, Code, CodeWScope.
- Output from the *pipeline* can only contain 16 megabytes. If your result set exceeds this limit, the aggregate (page 740) command produces an error.
- If any single aggregation operation consumes more than 10 percent of system RAM the operation will produce an error.

Aggregation Framework Examples

MongoDB provides flexible data aggregation functionality with the `aggregate` (page 740) command. For additional information about aggregation consider the following resources:

- *Aggregation Framework* (page 195)
- *Aggregation Framework Reference* (page 211)
- *SQL to Aggregation Framework Mapping Chart* (page 879)

This document provides a number of practical examples that display the capabilities of the aggregation framework. All examples use a publicly available data set of all zipcodes and populations in the United States.

20.1 Requirements

`mongod` (page 897) and `mongo` (page 908), version 2.2 or later.

20.2 Aggregations using the Zip Code Data Set

To run you will need the zipcode data set. These data are available at: media.mongodb.org/zips.json. Use `mongoimport` (page 925) to load this data set into your `mongod` (page 897) instance.

20.2.1 Data Model

Each document in this collection has the following form:

```
{
  "_id": "10280",
  "city": "NEW YORK",
  "state": "NY",
  "pop": 5574,
  "loc": [
    -74.016323,
    40.710537
  ]
}
```

In these documents:

- The _id field holds the zipcode as a string.
- The city field holds the city.
- The state field holds the two letter state abbreviation.
- The pop field holds the population.
- The loc field holds the location as a latitude longitude pair.

All of the following examples use the aggregate() (page 815) helper in the mongo (page 908) shell. aggregate() (page 815) provides a wrapper around the aggregate (page 740) database command. See the documentation for your *driver* (page 435) for a more idiomatic interface for data aggregation operations.

20.2.2 States with Populations Over 10 Million

To return all states with a population greater than 10 million, use the following aggregation operation:

```
db.zipcodes.aggregate( { $group :
                         { _id : "$state",
                           totalPop : { $sum : "$pop" } } },
                       { $match : {totalPop : { $gte : 10*1000*1000 } } } )
```

Aggregations operations using the aggregate() (page 815) helper, process all documents on the zipcodes collection. aggregate() (page 815) a number of *pipeline* (page 195) operators that define the aggregation process.

In the above example, the pipeline passes all documents in the zipcodes collection through the following steps:

- the $group (page 728) operator collects all documents and creates documents for each state.

  These new per-state documents have one field in addition the _id field: totalPop which is a generated field using the $sum (page 737) operation to calculate the total value of all pop fields in the source documents.

  After the $group (page 728) operation the documents in the pipeline resemble the following:

  ```
  {
    "_id" : "AK",
    "totalPop" : 550043
  }
  ```

- the $match (page 731) operation filters these documents so that the only documents that remain are those where the value of totalPop is greater than or equal to 10 million.

  The $match (page 731) operation does not alter the documents, which have the same format as the documents output by $group (page 728).

The equivalent *SQL* for this operation is:

```
SELECT state, SUM(pop) AS pop
       FROM zips
       GROUP BY state
       HAVING pop > (10*1000*1000)
```

20.2.3 Average City Population by State

To return the average populations for cities in each state, use the following aggregation operation:

```
db.zipcodes.aggregate( { $group :
                         { _id : { state : "$state", city : "$city" },
                           pop : { $sum : "$pop" } } },
                       { $group :
                       { _id : "$_id.state",
                         avgCityPop : { $avg : "$pop" } } } )
```

Aggregations operations using the `aggregate()` (page 815) helper, process all documents on the `zipcodes` collection. `aggregate()` (page 815) a number of *pipeline* (page 195) operators that define the aggregation process.

In the above example, the pipeline passes all documents in the `zipcodes` collection through the following steps:

- the `$group` (page 728) operator collects all documents and creates new documents for every combination of the `city` and `state` fields in the source document.

  After this stage in the pipeline, the documents resemble the following:

  ```
  {
    "_id" : {
      "state" : "CO",
      "city" : "EDGEWATER"
    },
    "pop" : 13154
  }
  ```

- the second `$group` (page 728) operator collects documents by the `state` field and use the `$avg` (page 727) expression to compute a value for the `avgCityPop` field.

The final output of this aggregation operation is:

```
{
  "_id" : "MN",
  "avgCityPop" : 5335
},
```

20.2.4 Largest and Smallest Cities by State

To return the smallest and largest cities by population for each state, use the following aggregation operation:

```
db.zipcodes.aggregate( { $group:
                         { _id: { state: "$state", city: "$city" },
                           pop: { $sum: "$pop" } } },
                       { $sort: { pop: 1 } },
                       { $group:
                         { _id : "$_id.state",
                           biggestCity:  { $last: "$_id.city" },
                           biggestPop:   { $last: "$pop" },
                           smallestCity: { $first: "$_id.city" },
                           smallestPop:  { $first: "$pop" } } },

                       // the following $project is optional, and
                       // modifies the output format.

                       { $project:
                         { _id: 0,
                           state: "$_id",
                           biggestCity:  { name: "$biggestCity",  pop: "$biggestPop" },
                           smallestCity: { name: "$smallestCity", pop: "$smallestPop" } } } )
```

Aggregations operations using the `aggregate()` (page 815) helper, process all documents on the `zipcodes` collection. `aggregate()` (page 815) a number of *pipeline* (page 195) operators that define the aggregation process.

All documents from the `zipcodes` collection pass into the pipeline, which consists of the following steps:

- the `$group` (page 728) operator collects all documents and creates new documents for every combination of the `city` and `state` fields in the source documents.

  By specifying the value of `_id` as a sub-document that contains both fields, the operation preserves the `state` field for use later in the pipeline. The documents produced by this stage of the pipeline have a second field, `pop`, which uses the `$sum` (page 737) operator to provide the total of the `pop` fields in the source document.

  At this stage in the pipeline, the documents resemble the following:

  ```
  {
    "_id" : {
      "state" : "CO",
      "city" : "EDGEWATER"
    },
    "pop" : 13154
  }
  ```

- `$sort` (page 735) operator orders the documents in the pipeline based on the vale of the `pop` field from largest to smallest. This operation does not alter the documents.

- the second `$group` (page 728) operator collects the documents in the pipeline by the `state` field, which is a field inside the nested `_id` document.

  Within each per-state document this `$group` (page 728) operator specifies four fields: Using the `$last` (page 730) expression, the `$group` (page 728) operator creates the `biggestcity` and `biggestpop` fields that store the city with the largest population and that population. Using the `$first` (page 728) expression, the `$group` (page 728) operator creates the `smallestcity` and `smallestpop` fields that store the city with the smallest population and that population.

  The documents, at this stage in the pipeline resemble the following:

  ```
  {
    "_id" : "WA",
    "biggestCity" : "SEATTLE",
    "biggestPop" : 520096,
    "smallestCity" : "BENGE",
    "smallestPop" : 2
  }
  ```

- The final operation is `$project` (page 733), which renames the `_id` field to `state` and moves the `biggestCity`, `biggestPop`, `smallestCity`, and `smallestPop` into `biggestCity` and `smallestCity` sub-documents.

The final output of this aggregation operation is:

```
{
  "state" : "RI",
  "biggestCity" : {
    "name" : "CRANSTON",
    "pop" : 176404
  },
  "smallestCity" : {
    "name" : "CLAYVILLE",
    "pop" : 45
  }
}
```

20.3 Aggregation with User Preference Data

20.3.1 Data Model

Consider a hypothetical sports club with a database that contains a `user` collection that tracks user's join dates, sport preferences, and stores these data in documents that resemble the following:

```
{
  _id : "jane",
  joined : ISODate("2011-03-02"),
  likes : ["golf", "racquetball"]
}
{
  _id : "joe",
  joined : ISODate("2012-07-02"),
  likes : ["tennis", "golf", "swimming"]
}
```

20.3.2 Normalize and Sort Documents

The following operation returns user names in upper case and in alphabetical order. The aggregation includes user names for all documents in the `users` collection. You might do this to normalize user names for processing.

```
db.users.aggregate(
  [
    { $project : { name:{$toUpper:"$_id"} , _id:0 } },
    { $sort : { name : 1 } }
  ]
)
```

All documents from the `users` collection passes through the pipeline, which consists of the following operations:

- The `$project` (page 733) operator:
  - creates a new field called `name`.
  - converts the value of the `_id` to upper case, with the `$toUpper` (page 737) operator. Then the `$project` (page 733) creates a new filed, named `name` to hold this value.
  - suppresses the `id` field. `$project` (page 733) will pass the `_id` field by default, unless explicitly suppressed.
- The `$sort` (page 735) operator orders the results by the `name` field.

The results of the aggregation would resemble the following:

```
{
  "name" : "JANE"
},
{
  "name" : "JILL"
},
{
  "name" : "JOE"
}
```

20.3.3 Return Usernames Ordered by Join Month

The following aggregation operation returns user names sorted by the month they joined. This kind of aggregation could help generate membership renewal notices.

```
db.users.aggregate(
  [
    { $project : { month_joined : {
                                      $month : "$joined"
                                    },
                   name : "$_id",
                   _id : 0
                 },
    { $sort : { month_joined : 1 } }
  ]
)
```

The pipeline passes all documents in the `users` collection through the following operations:

- The `$project` (page 733) operator:
  - Creates two new fields: `month_joined` and `name`.
  - Suppresses the `id` from the results. The `aggregate()` (page 815) method includes the `_id`, unless explicitly suppressed.
- The `$month` (page 732) operator converts the values of the `joined` field to integer representations of the month. Then the `$project` (page 733) operator assigns those values to the `month_joined` field.
- The `$sort` (page 735) operator sorts the results by the `month_joined` field.

The operation returns results that resemble the following:

```
{
  "month_joined" : 1,
  "name" : "ruth"
},
{
  "month_joined" : 1,
  "name" : "harold"
},
{
  "month_joined" : 1,
  "name" : "kate"
}
{
  "month_joined" : 2,
  "name" : "jill"
}
```

20.3.4 Return Total Number of Joins per Month

The following operation shows how many people joined each month of the year. You might use this aggregated data for such information for recruiting and marketing strategies.

```
db.users.aggregate(
  [
    { $project : { month_joined : { $month : "$joined" } } } ,
    { $group : { _id : {month_joined:"$month_joined"} , number : { $sum : 1 } } },
```

```
    { $sort : { "_id.month_joined" : 1 } }
  ]
)
```

The pipeline passes all documents in the `users` collection through the following operations:

- The `$project` (page 733) operator creates a new field called `month_joined`.
- The `$month` (page 732) operator converts the values of the `joined` field to integer representations of the month. Then the `$project` (page 733) operator assigns the values to the `month_joined` field.
- The `$group` (page 728) operator collects all documents with a given `month_joined` value and counts how many documents there are for that value. Specifically, for each unique value, `$group` (page 728) creates a new "per-month" document with two fields:
  - `_id`, which contains a nested document with the `month_joined` field and its value.
  - `number`, which is a generated field. The `$sum` (page 737) operator increments this field by 1 for every document containing the given `month_joined` value.
- The `$sort` (page 735) operator sorts the documents created by `$group` (page 728) according to the contents of the `month_joined` field.

The result of this aggregation operation would resemble the following:

```
{
  "_id" : {
    "month_joined" : 1
  },
  "number" : 3
},
{
  "_id" : {
    "month_joined" : 2
  },
  "number" : 9
},
{
  "_id" : {
    "month_joined" : 3
  },
  "number" : 5
}
```

20.3.5 Return the Five Most Common "Likes"

The following aggregation collects top five most "liked" activities in the data set. In this data set, you might use an analysis of this to help inform planning and future development.

```
db.users.aggregate(
  [
    { $unwind : "$likes" },
    { $group : { _id : "$likes" , number : { $sum : 1 } } },
    { $sort : { number : -1 } },
    { $limit : 5 }
  ]
)
```

The pipeline begins with all documents in the `users` collection, and passes these documents through the following operations:

- The `$unwind` (page 737) operator separates each value in the `likes` array, and creates a new version of the source document for every element in the array.

  Example

  Given the following document from the `users` collection:

  ```
  {
    _id : "jane",
    joined : ISODate("2011-03-02"),
    likes : ["golf", "racquetball"]
  }
  ```

  The `$unwind` (page 737) operator would create the following documents:

  ```
  {
    _id : "jane",
    joined : ISODate("2011-03-02"),
    likes : "golf"
  }
  {
    _id : "jane",
    joined : ISODate("2011-03-02"),
    likes : "racquetball"
  }
  ```

- The `$group` (page 728) operator collects all documents the same value for the `likes` field and counts each grouping. With this information, `$group` (page 728) creates a new document with two fields:
  - `_id`, which contains the `likes` value.
  - `number`, which is a generated field. The `$sum` (page 737) operator increments this field by 1 for every document containing the given `likes` value.
- The `$sort` (page 735) operator sorts these documents by the `number` field in reverse order.
- The `$limit` (page 730) operator only includes the first 5 result documents.

The results of aggregation would resemble the following:

```
{
  "_id" : "golf",
  "number" : 33
},
{
  "_id" : "racquetball",
  "number" : 31
},
{
  "_id" : "swimming",
  "number" : 24
},
{
  "_id" : "handball",
  "number" : 19
},
{
```

```
  "_id" : "tennis",
  "number" : 18
}
```

CHAPTER 21

Aggregation Framework Reference

New in version 2.1.0. The aggregation framework provides the ability to project, process, and/or control the output of the query, without using *map-reduce*. Aggregation uses a syntax that resembles the same syntax and form as "regular" MongoDB database queries.

These aggregation operations are all accessible by way of the `aggregate()` (page 815) method. While all examples in this document use this method, `aggregate()` (page 815) is merely a wrapper around the *database command* `aggregate` (page 740). The following prototype aggregation operations are equivalent:

```
db.people.aggregate( <pipeline> )
db.people.aggregate( [<pipeline>] )
db.runCommand( { aggregate: "people", pipeline: [<pipeline>] } )
```

These operations perform aggregation routines on the collection named `people`. `<pipeline>` is a placeholder for the aggregation *pipeline* definition. `aggregate()` (page 815) accepts the stages of the pipeline (i.e. `<pipeline>`) as an array, or as arguments to the method.

This documentation provides an overview of all aggregation operators available for use in the aggregation pipeline as well as details regarding their use and behavior.

See Also:

Aggregation Framework (page 195) overview, the *Aggregation Framework Documentation Index* (page 193), and the *Aggregation Framework Examples* (page 201) for more information on the aggregation functionality.

Aggregation Operators:

- Pipeline (page 212)
- Expressions (page 218)
  - `$group` Operators (page 218)
  - Boolean Operators (page 219)
  - Comparison Operators (page 219)
  - Arithmetic Operators (page 220)
  - String Operators (page 220)
  - Date Operators (page 221)
  - Conditional Expressions (page 222)

21.1 Pipeline

Warning: The pipeline cannot operate on values of the following types: `Binary`, `Symbol`, `MinKey`, `MaxKey`, `DBRef`, `Code`, and `CodeWScope`.

Pipeline operators appear in an array. Conceptually, documents pass through these operators in a sequence. All examples in this section assume that the aggregation pipeline begins with a collection named `article` that contains documents that resemble the following:

```
{
  title : "this is my title" ,
  author : "bob" ,
  posted : new Date() ,
  pageViews : 5 ,
  tags : [ "fun" , "good" , "fun" ] ,
  comments : [
      { author :"joe" , text : "this is cool" } ,
      { author :"sam" , text : "this is bad" }
  ],
  other : { foo : 5 }
}
```

The current pipeline operators are:

$project

Reshapes a document stream by renaming, adding, or removing fields. Also use `$project` (page 733) to create computed values or sub-objects. Use `$project` (page 733) to:

- Include fields from the original document.
- Insert computed fields.
- Rename fields.
- Create and populate fields that hold sub-documents.

Use `$project` (page 733) to quickly select the fields that you want to include or exclude from the response. Consider the following aggregation framework operation.

```
db.article.aggregate(
    { $project : {
        title : 1 ,
        author : 1 ,
    }}
 );
```

This operation includes the `title` field and the `author` field in the document that returns from the aggregation *pipeline*.

Note: The `_id` field is always included by default. You may explicitly exclude `_id` as follows:

```
db.article.aggregate(
    { $project : {
        _id : 0 ,
        title : 1 ,
        author : 1
    }}
);
```

Here, the projection excludes the _id field but includes the title and author fields.

Projections can also add computed fields to the document stream passing through the pipeline. A computed field can use any of the *expression operators* (page 218). Consider the following example:

```
db.article.aggregate(
    { $project : {
        title : 1,
        doctoredPageViews : { $add:["$pageViews", 10] }
    }}
);
```

Here, the field doctoredPageViews represents the value of the pageViews field after adding 10 to the original field using the $add (page 727).

Note: You must enclose the expression that defines the computed field in braces, so that the expression is a valid object.

You may also use $project (page 733) to rename fields. Consider the following example:

```
db.article.aggregate(
    { $project : {
        title : 1 ,
        page_views : "$pageViews" ,
        bar : "$other.foo"
    }}
);
```

This operation renames the pageViews field to page_views, and renames the foo field in the other sub-document as the top-level field bar. The field references used for renaming fields are direct expressions and do not use an operator or surrounding braces. All aggregation field references can use dotted paths to refer to fields in nested documents.

Finally, you can use the $project (page 733) to create and populate new sub-documents. Consider the following example that creates a new object-valued field named stats that holds a number of values:

```
db.article.aggregate(
    { $project : {
        title : 1 ,
        stats : {
            pv : "$pageViews",
            foo : "$other.foo",
            dpv : { $add:["$pageViews", 10] }
        }
    }}
);
```

This projection includes the title field and places $project (page 733) into "inclusive" mode. Then, it creates the stats documents with the following fields:

- pv which includes and renames the pageViews from the top level of the original documents.
- foo which includes the value of other.foo from the original documents.
- dpv which is a computed field that adds 10 to the value of the pageViews field in the original document using the $add (page 727) aggregation expression.

$match

Provides a query-like interface to filter documents out of the aggregation *pipeline*. The $match (page 731)

drops documents that do not match the condition from the aggregation pipeline, and it passes documents that match along the pipeline unaltered.

The syntax passed to the $match (page 731) is identical to the *query* syntax. Consider the following prototype form:

```
db.article.aggregate(
    { $match : <match-predicate> }
);
```

The following example performs a simple field equality test:

```
db.article.aggregate(
    { $match : { author : "dave" } }
);
```

This operation only returns documents where the author field holds the value dave. Consider the following example, which performs a range test:

```
db.article.aggregate(
    { $match : { score  : { $gt : 50, $lte : 90 } } }
);
```

Here, all documents return when the score field holds a value that is greater than 50 and less than or equal to 90.

Note: Place the $match (page 731) as early in the aggregation *pipeline* as possible. Because $match (page 731) limits the total number of documents in the aggregation pipeline, earlier $match (page 731) operations minimize the amount of later processing. If you place a $match (page 731) at the very beginning of a pipeline, the query can take advantage of *indexes* like any other db.collection.find() (page 820) or db.collection.findOne() (page 825).

Warning: You cannot use $where (page 720) or *geospatial operations* (page 883) in $match (page 731) queries as part of the aggregation pipeline.

$limit

Restricts the number of *documents* that pass through the $limit (page 730) in the *pipeline*.

$limit (page 730) takes a single numeric (positive whole number) value as a parameter. Once the specified number of documents pass through the pipeline operator, no more will. Consider the following example:

```
db.article.aggregate(
    { $limit : 5 }
);
```

This operation returns only the first 5 documents passed to it from by the pipeline. $limit (page 730) has no effect on the content of the documents it passes.

$skip

Skips over the specified number of *documents* that pass through the $skip (page 735) in the *pipeline* before passing all of the remaining input.

$skip (page 735) takes a single numeric (positive whole number) value as a parameter. Once the operation has skipped the specified number of documents, it passes all the remaining documents along the *pipeline* without alteration. Consider the following example:

```
db.article.aggregate(
    { $skip : 5 }
);
```

This operation skips the first 5 documents passed to it by the pipeline. $skip (page 735) has no effect on the content of the documents it passes along the pipeline.

$unwind

Peels off the elements of an array individually, and returns a stream of documents. $unwind (page 737) returns one document for every member of the unwound array within every source document. Take the following aggregation command:

```
db.article.aggregate(
    { $project : {
        author : 1 ,
        title : 1 ,
        tags : 1
    }},
    { $unwind : "$tags" }
);
```

Note: The dollar sign (i.e. $) must proceed the field specification handed to the $unwind (page 737) operator.

In the above aggregation $project (page 733) selects (inclusively) the author, title, and tags fields, as well as the _id field implicitly. Then the pipeline passes the results of the projection to the $unwind (page 737) operator, which will unwind the tags field. This operation may return a sequence of documents that resemble the following for a collection that contains one document holding a tags field with an array of 3 items.

```
{
     "result" : [
             {
                     "_id" : ObjectId("4e6e4ef557b77501a49233f6"),
                     "title" : "this is my title",
                     "author" : "bob",
                     "tags" : "fun"
             },
             {
                     "_id" : ObjectId("4e6e4ef557b77501a49233f6"),
                     "title" : "this is my title",
                     "author" : "bob",
                     "tags" : "good"
             },
             {
                     "_id" : ObjectId("4e6e4ef557b77501a49233f6"),
                     "title" : "this is my title",
                     "author" : "bob",
                     "tags" : "fun"
             }
     ],
     "OK" : 1
}
```

A single document becomes 3 documents: each document is identical except for the value of the tags field. Each value of tags is one of the values in the original "tags" array.

Note: $unwind (page 737) has the following behaviors:

- $unwind (page 737) is most useful in combination with $group (page 728).

- You may undo the effects of unwind operation with the $group (page 728) pipeline operator.
- If you specify a target field for $unwind (page 737) that does not exist in an input document, the pipeline ignores the input document, and will generate no result documents.
- If you specify a target field for $unwind (page 737) that is not an array, db.collection.aggregate() (page 815) generates an error.
- If you specify a target field for $unwind (page 737) that holds an empty array ([]) in an input document, the pipeline ignores the input document, and will generates no result documents.

$group

Groups documents together for the purpose of calculating aggregate values based on a collection of documents. Practically, group often supports tasks such as average page views for each page in a website on a daily basis.

The output of $group (page 728) depends on how you define groups. Begin by specifying an identifier (i.e. a _id field) for the group you're creating with this pipeline. You can specify a single field from the documents in the pipeline, a previously computed value, or an aggregate key made up from several incoming fields. Aggregate keys may resemble the following document:

```
{ _id : { author: '$author', pageViews: '$pageViews', posted: '$posted' } }
```

With the exception of the _id field, $group (page 728) cannot output nested documents.

Every group expression must specify an _id field. You may specify the _id field as a dotted field path reference, a document with multiple fields enclosed in braces (i.e. { and }), or a constant value.

Note: Use $project (page 733) as needed to rename the grouped field after an $group (page 728) operation, if necessary.

Consider the following example:

```
db.article.aggregate(
    { $group : {
        _id : "$author",
        docsPerAuthor : { $sum : 1 },
        viewsPerAuthor : { $sum : "$pageViews" }
    }}
);
```

This groups by the author field and computes two fields, the first docsPerAuthor is a counter field that adds one for each document with a given author field using the $sum (page 737) function. The viewsPerAuthor field is the sum of all of the pageViews fields in the documents for each group.

Each field defined for the $group (page 728) must use one of the group aggregation function listed below to generate its composite value:

- $addToSet (page 727)
- $first (page 728)
- $last (page 730)
- $max (page 732)
- $min (page 732)
- $avg (page 727)
- $push (page 734)
- $sum (page 737)

Warning: The aggregation system currently stores $group (page 728) operations in memory, which may cause problems when processing a larger number of groups.

$sort

The $sort (page 735) *pipeline* operator sorts all input documents and returns them to the pipeline in sorted order. Consider the following prototype form:

```
db.<collection-name>.aggregate(
    { $sort : { <sort-key> } }
);
```

This sorts the documents in the collection named <collection-name>, according to the key and specification in the { <sort-key> } document.

Specify the sort in a document with a field or fields that you want to sort by and a value of 1 or -1 to specify an ascending or descending sort respectively, as in the following example:

```
db.users.aggregate(
    { $sort : { age : -1, posts: 1 } }
);
```

This operation sorts the documents in the users collection, in descending order according by the age field and then in ascending order according to the value in the posts field.

When comparing values of different *BSON* types, MongoDB uses the following comparison order, from lowest to highest:

1. MinKey (internal type)
2. Null
3. Numbers (ints, longs, doubles)
4. Symbol, String
5. Object
6. Array
7. BinData
8. ObjectID
9. Boolean
10. Date, Timestamp
11. Regular Expression
12. MaxKey (internal type)

Note: MongoDB treats some types as equivalent for comparison purposes. For instance, numeric types undergo conversion before comparison.

Note: The $sort (page 735) cannot begin sorting documents until previous operators in the pipeline have returned all output.

- $skip (page 735)

$sort (page 735) operator can take advantage of an index when placed at the **beginning** of the pipeline or placed **before** the following aggregation operators:

- $project (page 733)
- $unwind (page 737)
- $group (page 728).

Warning: Unless the $sort (page 735) operator can use an index, in the current release, the sort must fit within memory. This may cause problems when sorting large numbers of documents.

21.2 Expressions

These operators calculate values within the *aggregation framework*.

21.2.1 $group Operators

The $group (page 728) pipeline stage provides the following operations:

$addToSet
Returns an array of all the values found in the selected field among the documents in that group. *Every unique value only appears once* in the result set. There is no ordering guarantee for the output documents.

$first
Returns the first value it encounters for its group .

Note: Only use $first (page 728) when the $group (page 728) follows an $sort (page 735) operation. Otherwise, the result of this operation is unpredictable.

$last
Returns the last value it encounters for its group.

Note: Only use $last (page 730) when the $group (page 728) follows an $sort (page 735) operation. Otherwise, the result of this operation is unpredictable.

$max
Returns the highest value among all values of the field in all documents selected by this group.

$min
Returns the lowest value among all values of the field in all documents selected by this group.

$avg
Returns the average of all the values of the field in all documents selected by this group.

$push
Returns an array of all the values found in the selected field among the documents in that group. *A value may appear more than once* in the result set if more than one field in the grouped documents has that value.

$sum
Returns the sum of all the values for a specified field in the grouped documents, as in the second use above.

Alternately, if you specify a value as an argument, $sum (page 737) will increment this field by the specified value for every document in the grouping. Typically, as in the first use above, specify a value of 1 in order to count members of the group.

21.2.2 Boolean Operators

The three boolean operators accept Booleans as arguments and return Booleans as results.

Note: These operators convert non-booleans to Boolean values according to the BSON standards. Here, `null`, `undefined`, and `0` values become `false`, while non-zero numeric values, and all other types, such as strings, dates, objects become `true`.

`$and`

Takes an array one or more values and returns `true` if *all* of the values in the array are `true`. Otherwise `$and` (page 727) returns `false`.

Note: `$and` (page 727) uses short-circuit logic: the operation stops evaluation after encountering the first `false` expression.

`$or`

Takes an array of one or more values and returns `true` if *any* of the values in the array are `true`. Otherwise `$or` (page 733) returns false.

Note: `$or` (page 733) uses short-circuit logic: the operation stops evaluation after encountering the first `true` expression.

`$not`

Returns the boolean opposite value passed to it. When passed a `true` value, `$not` (page 732) returns `false`; when passed a `false` value, `$not` (page 732) returns `true`.

21.2.3 Comparison Operators

These operators perform comparisons between two values and return a Boolean, in most cases, reflecting the result of that comparison.

All comparison operators take an array with a pair of values. You may compare numbers, strings, and dates. Except for `$cmp` (page 727), all comparison operators return a Boolean value. `$cmp` (page 727) returns an integer.

`$cmp`

Takes two values in an array and returns an integer. The returned value is:

- A negative number if the first value is less than the second.
- A positive number if the first value is greater than the second.
- `0` if the two values are equal.

`$eq`

Takes two values in an array and returns a boolean. The returned value is:

- `true` when the values are equivalent.
- `false` when the values are **not** equivalent.

`$gt`

Takes two values in an array and returns an boolean. The returned value is:

- `true` when the first value is *greater than* the second value.
- `false` when the first value is *less than or equal to* the second value.

$gte
Takes two values in an array and returns an boolean. The returned value is:

- `true` when the first value is *greater than or equal* to the second value.
- `false` when the first value is *less than* the second value.

$lt
Takes two values in an array and returns an boolean. The returned value is:

- `true` when the first value is *less than* the second value.
- `false` when the first value is *greater than or equal to* the second value.

$lte
Takes two values in an array and returns an boolean. The returned value is:

- `true` when the first value is *less than or equal to* the second value.
- `false` when the first value is *greater than* the second value.

$ne
Takes two values in an array returns an boolean. The returned value is:

- `true` when the values are **not equivalent**.
- `false` when the values are **equivalent**.

21.2.4 Arithmetic Operators

These operators only support numbers.

$add
Takes an array of one or more numbers and adds them together, returning the sum.

$divide
Takes an array that contains a pair of numbers and returns the value of the first number divided by the second number.

$mod
Takes an array that contains a pair of numbers and returns the *remainder* of the first number divided by the second number.

See Also:

`$mod` (page 703)

$multiply
Takes an array of one or more numbers and multiples them, returning the resulting product.

$subtract
Takes an array that contains a pair of numbers and subtracts the second from the first, returning their difference.

21.2.5 String Operators

These operators manipulate strings within projection expressions.

$strcasecmp
Takes in two strings. Returns a number. `$strcasecmp` (page 736) is positive if the first string is "greater than" the second and negative if the first string is "less than" the second. `$strcasecmp` (page 736) returns 0 if the strings are identical.

Note: $strcasecmp (page 736) may not make sense when applied to glyphs outside the Roman alphabet.

$strcasecmp (page 736) internally capitalizes strings before comparing them to provide a case-*insensitive* comparison. Use $cmp (page 727) for a case sensitive comparison.

$substr

$substr (page 736) takes a string and two numbers. The first number represents the number of bytes in the string to skip, and the second number specifies the number of bytes to return from the string.

Note: $substr (page 736) is not encoding aware and if used improperly may produce a result string containing an invalid UTF-8 character sequence.

$toLower

Takes a single string and converts that string to lowercase, returning the result. All uppercase letters become lowercase.

Note: $toLower (page 737) may not make sense when applied to glyphs outside the Roman alphabet.

$toUpper

Takes a single string and converts that string to uppercase, returning the result. All lowercase letters become uppercase.

Note: $toUpper (page 737) may not make sense when applied to glyphs outside the Roman alphabet.

21.2.6 Date Operators

All date operators take a "Date" typed value as a single argument and return a number.

$dayOfYear

Takes a date and returns the day of the year as a number between 1 and 366.

$dayOfMonth

Takes a date and returns the day of the month as a number between 1 and 31.

$dayOfWeek

Takes a date and returns the day of the week as a number between 1 (Sunday) and 7 (Saturday.)

$year

Takes a date and returns the full year.

$month

Takes a date and returns the month as a number between 1 and 12.

$week

Takes a date and returns the week of the year as a number between 0 and 53.

Weeks begin on Sundays, and week 1 begins with the first Sunday of the year. Days preceding the first Sunday of the year are in week 0. This behavior is the same as the "%U" operator to the strftime standard library function.

$hour

Takes a date and returns the hour between 0 and 23.

$minute

Takes a date and returns the minute between 0 and 59.

$second
Takes a date and returns the second between 0 and 59, but can be 60 to account for leap seconds.

21.2.7 Conditional Expressions

$cond
Use the $cond (page 727) operator with the following syntax:

```
{ $cond: [ <boolean-expression>, <true-case>, <false-case> ] }
```

Takes an array with three expressions, where the first expression evaluates to a Boolean value. If the first expression evaluates to true, $cond (page 727) returns the value of the second expression. If the first expression evaluates to false, $cond (page 727) evaluates and returns the third expression.

$ifNull
Use the $ifNull (page 730) operator with the following syntax:

```
{ $ifNull: [ <expression>, <replacement-if-null> ] }
```

Takes an array with two expressions. $ifNull (page 730) returns the first expression if it evaluates to a non-null value. Otherwise, $ifNull (page 730) returns the second expression's value.

CHAPTER 22

Map-Reduce

Map-reduce operations can handle complex aggregation tasks. To perform map-reduce operations, MongoDB provides the `mapReduce` (page 775) command and, in the `mongo` (page 908) shell, the `db.collection.mapReduce()` (page 832) wrapper method.

For many simple aggregation tasks, see the *aggregation framework* (page 195).

22.1 Map-Reduce Examples

This section provides some map-reduce examples in the `mongo` (page 908) shell using the `db.collection.mapReduce()` (page 832) method:

```
db.collection.mapReduce(
                         <mapfunction>,
                         <reducefunction>,
                         {
                           out: <collection>,
                           query: <document>,
                           sort: <document>,
                           limit: <number>,
                           finalize: <function>,
                           scope: <document>,
                           jsMode: <boolean>,
                           verbose: <boolean>
                         }
                       )
```

For more information on the parameters, see the `db.collection.mapReduce()` (page 832) reference page .

Consider the following map-reduce operations on a collection `orders` that contains documents of the following prototype:

```
{
     _id: ObjectId("50a8240b927d5d8b5891743c"),
     cust_id: "abc123",
     ord_date: new Date("Oct 04, 2012"),
     status: 'A',
     price: 250,
     items: [ { sku: "mmm", qty: 5, price: 2.5 },
```

```
                { sku: "nnn", qty: 5, price: 2.5 } ]
}
```

22.1.1 Return the Total Price Per Customer Id

Perform map-reduce operation on the `orders` collection to group by the `cust_id`, and for each `cust_id`, calculate the sum of the `price` for each `cust_id`:

1. Define the map function to process each input document:
   - In the function, `this` refers to the document that the map-reduce operation is processing.
   - The function maps the `price` to the `cust_id` for each document and emits the `cust_id` and `price` pair.

   ```
   var mapFunction1 = function() {
                          emit(this.cust_id, this.price);
                      };
   ```

2. Define the corresponding reduce function with two arguments `keyCustId` and `valuesPrices`:
   - The `valuesPrices` is an array whose elements are the `price` values emitted by the map function and grouped by `keyCustId`.
   - The function reduces the `valuesPrice` array to the sum of its elements.

   ```
   var reduceFunction1 = function(keyCustId, valuesPrices) {
                             return Array.sum(valuesPrices);
                         };
   ```

3. Perform the map-reduce on all documents in the `orders` collection using the `mapFunction1` map function and the `reduceFunction1` reduce function.

   ```
   db.orders.mapReduce(
                          mapFunction1,
                          reduceFunction1,
                          { out: "map_reduce_example" }
                        )
   ```

   This operation outputs the results to a collection named `map_reduce_example`. If the `map_reduce_example` collection already exists, the operation will replace the contents with the results of this map-reduce operation:

22.1.2 Calculate the Number of Orders, Total Quantity, and Average Quantity Per Item

In this example you will perform a map-reduce operation on the `orders` collection, for all documents that have an `ord_date` value greater than `01/01/2012`. The operation groups by the `item.sku` field, and for each `sku` calculates the number of orders and the total quantity ordered. The operation concludes by calculating the average quantity per order for each `sku` value:

1. Define the map function to process each input document:
   - In the function, `this` refers to the document that the map-reduce operation is processing.
   - For each item, the function associates the `sku` with a new object `value` that contains the `count` of `1` and the item `qty` for the order and emits the `sku` and `value` pair.

```
var mapFunction2 = function() {
                       for (var idx = 0; idx < this.items.length; idx++) {
                           var key = this.items[idx].sku;
                           var value = {
                                         count: 1,
                                         qty: this.items[idx].qty
                                       };
                           emit(key, value);
                       }
                   };
```

2. Define the corresponding reduce function with two arguments `keySKU` and `valuesCountObjects`:

   - `valuesCountObjects` is an array whose elements are the objects mapped to the grouped `keySKU` values passed by map function to the reducer function.
   - The function reduces the `valuesCountObjects` array to a single object `reducedValue` that also contains the `count` and the `qty` fields.
   - In `reducedValue`, the `count` field contains the sum of the `count` fields from the individual array elements, and the `qty` field contains the sum of the `qty` fields from the individual array elements.

```
var reduceFunction2 = function(keySKU, valuesCountObjects) {
                          reducedValue = { count: 0, qty: 0 };

                          for (var idx = 0; idx < valuesCountObjects.length; idx++) {
                              reducedValue.count += valuesCountObjects[idx].count;
                              reducedValue.qty += valuesCountObjects[idx].qty;
                          }

                          return reducedValue;
                      };
```

3. Define a finalize function with two arguments `key` and `reducedValue`. The function modifies the `reducedValue` object to add a computed field named `average` and returns the modified object:

```
var finalizeFunction2 = function (key, reducedValue) {

                            reducedValue.average = reducedValue.qty/reducedValue.count;

                            return reducedValue;
                        };
```

4. Perform the map-reduce operation on the `orders` collection using the `mapFunction2`, `reduceFunction2`, and `finalizeFunction2` functions.

```
db.orders.mapReduce( mapFunction2,
                     reduceFunction2,
                     {
                       out: { merge: "map_reduce_example" },
                       query: { ord_date: { $gt: new Date('01/01/2012') } },
                       finalize: finalizeFunction2
                     }
                   )
```

   This operation uses the `query` field to select only those documents with `ord_date` greater than `new Date(01/01/2012)`. Then it output the results to a collection `map_reduce_example`. If the `map_reduce_example` collection already exists, the operation will merge the existing contents with the results of this map-reduce operation:

22.2 Incremental Map-Reduce

If the map-reduce dataset is constantly growing, then rather than performing the map-reduce operation over the entire dataset each time you want to run map-reduce, you may want to perform an incremental map-reduce.

To perform incremental map-reduce:

1. Run a map-reduce job over the current collection and output the result to a separate collection.
2. When you have more data to process, run subsequent map-reduce job with:
   - the `query` parameter that specifies conditions that match *only* the new documents.
   - the `out` parameter that specifies the `reduce` action to merge the new results into the existing output collection.

Consider the following example where you schedule a map-reduce operation on a `sessions` collection to run at the end of each day.

22.2.1 Data Setup

The `sessions` collection contains documents that log users' session each day, for example:

```
db.sessions.save( { userid: "a", ts: ISODate('2011-11-03 14:17:00'), length: 95 } );
db.sessions.save( { userid: "b", ts: ISODate('2011-11-03 14:23:00'), length: 110 } );
db.sessions.save( { userid: "c", ts: ISODate('2011-11-03 15:02:00'), length: 120 } );
db.sessions.save( { userid: "d", ts: ISODate('2011-11-03 16:45:00'), length: 45 } );

db.sessions.save( { userid: "a", ts: ISODate('2011-11-04 11:05:00'), length: 105 } );
db.sessions.save( { userid: "b", ts: ISODate('2011-11-04 13:14:00'), length: 120 } );
db.sessions.save( { userid: "c", ts: ISODate('2011-11-04 17:00:00'), length: 130 } );
db.sessions.save( { userid: "d", ts: ISODate('2011-11-04 15:37:00'), length: 65 } );
```

22.2.2 Initial Map-Reduce of Current Collection

Run the first map-reduce operation as follows:

1. Define the `map` function that maps the `userid` to an object that contains the fields `userid`, `total_time`, `count`, and `avg_time`:

   ```
   var mapFunction = function() {
                         var key = this.userid;
                         var value = {
                                       userid: this.userid,
                                       total_time: this.length,
                                       count: 1,
                                       avg_time: 0
                                      };

                         emit( key, value );
                     };
   ```

2. Define the corresponding `reduce` function with two arguments `key` and `values` to calculate the total time and the count. The `key` corresponds to the `userid`, and the `values` is an array whose elements corresponds to the individual objects mapped to the `userid` in the `mapFunction`.

```
var reduceFunction = function(key, values) {

                          var reducedObject = {
                                                userid: key,
                                                total_time: 0,
                                                count:0,
                                                avg_time:0
                                              };

                          values.forEach( function(value) {
                                                reducedObject.total_time += value.total_time;
                                                reducedObject.count += value.count;
                                          }
                                        );
                          return reducedObject;
                        };
```

3. Define `finalize` function with two arguments `key` and `reducedValue`. The function modifies the `reducedValue` document to add another field `average` and returns the modified document.

```
var finalizeFunction = function (key, reducedValue) {

                           if (reducedValue.count > 0)
                               reducedValue.avg_time = reducedValue.total_time / reducedValue.cou

                           return reducedValue;
                         };
```

4. Perform map-reduce on the `session` collection using the `mapFunction`, the `reduceFunction`, and the `finalizeFunction` functions. Output the results to a collection `session_stat`. If the `session_stat` collection already exists, the operation will replace the contents:

```
db.sessions.mapReduce( mapFunction,
                       reduceFunction,
                       {
                         out: { reduce: "session_stat" },
                         finalize: finalizeFunction
                       }
                     )
```

22.2.3 Subsequent Incremental Map-Reduce

Later as the `sessions` collection grows, you can run additional map-reduce operations. For example, add new documents to the `sessions` collection:

```
db.sessions.save( { userid: "a", ts: ISODate('2011-11-05 14:17:00'), length: 100 } );
db.sessions.save( { userid: "b", ts: ISODate('2011-11-05 14:23:00'), length: 115 } );
db.sessions.save( { userid: "c", ts: ISODate('2011-11-05 15:02:00'), length: 125 } );
db.sessions.save( { userid: "d", ts: ISODate('2011-11-05 16:45:00'), length: 55 } );
```

At the end of the day, perform incremental map-reduce on the `sessions` collection but use the `query` field to select only the new documents. Output the results to the collection `session_stat`, but `reduce` the contents with the results of the incremental map-reduce:

```
db.sessions.mapReduce( mapFunction,
                       reduceFunction,
                       {
```

```
    query: { ts: { $gt: ISODate('2011-11-05 00:00:00') } },
    out: { reduce: "session_stat" },
    finalize: finalizeFunction
  }
);
```

22.3 Temporary Collection

The map-reduce operation uses a temporary collection during processing. At completion, the map-reduce operation renames the temporary collection. As a result, you can perform a map-reduce operation periodically with the same target collection name without affecting the intermediate states. Use this mode when generating statistical output collections on a regular basis.

22.4 Concurrency

The map-reduce operation is composed of many tasks, including:

- reads from the input collection,
- executions of the `map` function,
- executions of the `reduce` function,
- writes to the output collection.

These various tasks take the following locks:

- The read phase takes a read lock. It yields every 100 documents.
- The JavaScript code (i.e. `map`, `reduce`, `finalize` functions) is executed in a single thread, taking a JavaScript lock; however, most JavaScript tasks in map-reduce are very short and yield the lock frequently.
- The insert into the temporary collection takes a write lock for a single write.

  If the output collection does not exist, the creation of the output collection takes a write lock.

  If the output collection exists, then the output actions (i.e. `merge`, `replace`, `reduce`) take a write lock.

Although single-threaded, the map-reduce tasks interleave and appear to run in parallel.

Note: The final write lock during post-processing makes the results appear atomically. However, output actions `merge` and `reduce` may take minutes to process. For the `merge` and `reduce`, the `nonAtomic` flag is available. See the `db.collection.mapReduce()` (page 832) reference for more information.

22.5 Sharded Cluster

22.5.1 Sharded Input

When using sharded collection as the input for a map-reduce operation, `mongos` (page 905) will automatically dispatch the map-reduce job to each shard in parallel. There is no special option required. `mongos` (page 905) will wait for jobs on all shards to finish.

22.5.2 Sharded Output

By default the output collection is not sharded. The process is:

- `mongos` (page 905) dispatches a map-reduce finish job to the shard that will store the target collection.
- The target shard pulls results from all other shards, and runs a final reduce/finalize operation, and write to the output.
- If using the `sharded` option to the `out` parameter, MongoDB shards the output using `_id` field as the shard key. Changed in version 2.2.
- If the output collection does not exist, MongoDB creates and shards the collection on the `_id` field. If the collection is empty, MongoDB creates *chunks* using the result of the first stage of the map-reduce operation.
- `mongos` (page 905) dispatches, in parallel, a map-reduce finish job to every shard that owns a chunk.
- Each shard will pull the results it owns from all other shards, run a final reduce/finalize, and write to the output collection.

Note:

- During later map-reduce jobs, MongoDB splits chunks as needed.
- Balancing of chunks for the output collection is automatically prevented during post-processing to avoid concurrency issues.

In MongoDB 2.0:

- `mongos` (page 905) retrieves the results from each shard, and performs merge sort to order the results, and performs a reduce/finalize as needed. `mongos` (page 905) then writes the result to the output collection in sharded mode.
- This model requires only a small amount of memory, even for large datasets.
- Shard chunks are not automatically split during insertion. This requires manual intervention until the chunks are granular and balanced.

Warning: For best results, only use the sharded output options for `mapReduce` (page 775) in version 2.2 or later.

22.6 Troubleshooting Map-Reduce Operations

You can troubleshoot the `map` function and the `reduce` function in the `mongo` (page 908) shell.

22.6.1 Troubleshoot the Map Function

You can verify the `key` and `value` pairs emitted by the `map` function by writing your own `emit` function.

Consider a collection `orders` that contains documents of the following prototype:

```
{
     _id: ObjectId("50a8240b927d5d8b5891743c"),
     cust_id: "abc123",
     ord_date: new Date("Oct 04, 2012"),
     status: 'A',
     price: 250,
```

```
    items: [ { sku: "mmm", qty: 5, price: 2.5 },
             { sku: "nnn", qty: 5, price: 2.5 } ]
}
```

1. Define the `map` function that maps the `price` to the `cust_id` for each document and emits the `cust_id` and `price` pair:

   ```
   var map = function() {
       emit(this.cust_id, this.price);
   };
   ```

2. Define the `emit` function to print the key and value:

   ```
   var emit = function(key, value) {
       print("emit");
       print("key: " + key + "  value: " + tojson(value));
   }
   ```

3. Invoke the `map` function with a single document from the `orders` collection:

   ```
   var myDoc = db.orders.findOne( { _id: ObjectId("50a8240b927d5d8b5891743c") } );
   map.apply(myDoc);
   ```

4. Verify the key and value pair is as you expected.

   ```
   emit
   key: abc123 value:250
   ```

5. Invoke the `map` function with multiple documents from the `orders` collection:

   ```
   var myCursor = db.orders.find( { cust_id: "abc123" } );

   while (myCursor.hasNext()) {
       var doc = myCursor.next();
       print ("document _id= " + tojson(doc._id));
       map.apply(doc);
       print();
   }
   ```

6. Verify the key and value pairs are as you expected.

22.6.2 Troubleshoot the Reduce Function

Confirm Output Type

You can test that the `reduce` function returns a value that is the same type as the value emitted from the `map` function.

1. Define a `reduceFunction1` function that takes the arguments `keyCustId` and `valuesPrices`. `valuesPrices` is an array of integers:

   ```
   var reduceFunction1 = function(keyCustId, valuesPrices) {
                             return Array.sum(valuesPrices);
                         };
   ```

2. Define a sample array of integers:

   ```
   var myTestValues = [ 5, 5, 10 ];
   ```

3. Invoke the `reduceFunction1` with `myTestValues`:

```
reduceFunction1('myKey', myTestValues);
```

4. Verify the `reduceFunction1` returned an integer:

```
20
```

5. Define a `reduceFunction2` function that takes the arguments `keySKU` and `valuesCountObjects`. `valuesCountObjects` is an array of documents that contain two fields `count` and `qty`:

```
var reduceFunction2 = function(keySKU, valuesCountObjects) {
                          reducedValue = { count: 0, qty: 0 };

                          for (var idx = 0; idx < valuesCountObjects.length; idx++) {
                              reducedValue.count += valuesCountObjects[idx].count;
                              reducedValue.qty += valuesCountObjects[idx].qty;
                          }

                          return reducedValue;
                      };
```

6. Define a sample array of documents:

```
var myTestObjects = [
                      { count: 1, qty: 5 },
                      { count: 2, qty: 10 },
                      { count: 3, qty: 15 }
                    ];
```

7. Invoke the `reduceFunction2` with `myTestObjects`:

```
reduceFunction2('myKey', myTestObjects);
```

8. Verify the `reduceFunction2` returned a document with exactly the `count` and the `qty` field:

```
{ "count" : 6, "qty" : 30 }
```

Ensure Insensitivity to the Order of Mapped Values

The `reduce` function takes a `key` and a `values` array as its argument. You can test that the result of the `reduce` function does not depend on the order of the elements in the `values` array.

1. Define a sample `values1` array and a sample `values2` array that only differ in the order of the array elements:

```
var values1 = [
                { count: 1, qty: 5 },
                { count: 2, qty: 10 },
                { count: 3, qty: 15 }
              ];

var values2 = [
                { count: 3, qty: 15 },
                { count: 1, qty: 5 },
                { count: 2, qty: 10 }
              ];
```

2. Define a `reduceFunction2` function that takes the arguments `keySKU` and `valuesCountObjects`. `valuesCountObjects` is an array of documents that contain two fields `count` and `qty`:

```
var reduceFunction2 = function(keySKU, valuesCountObjects) {
                          reducedValue = { count: 0, qty: 0 };

                          for (var idx = 0; idx < valuesCountObjects.length; idx++) {
                              reducedValue.count += valuesCountObjects[idx].count;
                              reducedValue.qty += valuesCountObjects[idx].qty;
                          }

                          return reducedValue;
                      };
```

3. Invoke the `reduceFunction2` first with `values1` and then with `values2`:

```
reduceFunction2('myKey', values1);
reduceFunction2('myKey', values2);
```

4. Verify the `reduceFunction2` returned the same result:

```
{ "count" : 6, "qty" : 30 }
```

Ensure Reduce Function Idempotentcy

Because the map-reduce operation may call a `reduce` multiple times for the same key, the `reduce` function must return a value of the same type as the value emitted from the `map` function. You can test that the `reduce` function process "reduced" values without affecting the *final* value.

1. Define a `reduceFunction2` function that takes the arguments `keySKU` and `valuesCountObjects`. `valuesCountObjects` is an array of documents that contain two fields `count` and `qty`:

```
var reduceFunction2 = function(keySKU, valuesCountObjects) {
                          reducedValue = { count: 0, qty: 0 };

                          for (var idx = 0; idx < valuesCountObjects.length; idx++) {
                              reducedValue.count += valuesCountObjects[idx].count;
                              reducedValue.qty += valuesCountObjects[idx].qty;
                          }

                          return reducedValue;
                      };
```

2. Define a sample key:

```
var myKey = 'myKey';
```

3. Define a sample `valuesIdempotent` array that contains an element that is a call to the `reduceFunction2` function:

```
var valuesIdempotent = [
                         { count: 1, qty: 5 },
                         { count: 2, qty: 10 },
                         reduceFunction2(myKey, [ { count:3, qty: 15 } ] )
                       ];
```

4. Define a sample `values1` array that combines the values passed to `reduceFunction2`:

```
var values1 = [
                { count: 1, qty: 5 },
                { count: 2, qty: 10 },
```

```
    { count: 3, qty: 15 }
];
```

5. Invoke the `reduceFunction2` first with `myKey` and `valuesIdempotent` and then with `myKey` and `values1`:

   ```
   reduceFunction2(myKey, valuesIdempotent);
   reduceFunction2(myKey, values1);
   ```

6. Verify the `reduceFunction2` returned the same result:

   ```
   { "count" : 6, "qty" : 30 }
   ```

In addition to the aggregation framework, MongoDB provides simple *aggregation methods and commands* (page 235), that you may find useful for some classes of tasks:

CHAPTER 23

Simple Aggregation Methods and Commands

In addition to the *aggregation framework* (page 195) and *map-reduce*, MongoDB provides the following methods and commands to perform aggregation:

23.1 Count

MongoDB offers the following command and methods to provide `count` functionality:

- *count* (page 750)
- *db.collection.count()* (page 816)
- *cursor.count()* (page 804)

23.2 Distinct

MongoDB offers the following command and method to provide the `distinct` functionality:

- *distinct* (page 753)
- *db.collection.distinct()* (page 817)

23.3 Group

MongoDB offers the following command and method to provide `group` functionality:

- *group* (page 769)
- *db.collection.group()* (page 828)

Part VI

Indexes

Indexes provide high performance read operations for frequently used queries. Indexes are particularly useful where the total size of the documents exceeds the amount of available RAM.

For basic concepts and options, see *Indexing Overview* (page 241). For procedures and operational concerns, see *Indexing Operations* (page 251). For information on how applications might use indexes, see *Indexing Strategies* (page 257).

The following outlines the indexing documentation:

CHAPTER 24

Indexing Overview

This document provides an overview of indexes in MongoDB, including index types and creation options. For operational guidelines and procedures, see the *Indexing Operations* (page 251) document. For strategies and practical approaches, see the *Indexing Strategies* (page 257) document.

24.1 Synopsis

An index is a data structure that allows you to quickly locate documents based on the values stored in certain specified fields. Fundamentally, indexes in MongoDB are similar to indexes in other database systems. MongoDB supports indexes on any field or sub-field contained in documents within a MongoDB collection.

MongoDB indexes have the following core features:

- MongoDB defines indexes on a per-*collection* level.
- You can create indexes on a single field or on multiple fields using a *compound index* (page 243).
- Indexes enhance query performance, often dramatically. However, each index also incurs some overhead for every write operation. Consider the queries, the frequency of these queries, the size of your working set, the insert load, and your application's requirements as you create indexes in your MongoDB environment.
- All MongoDB indexes use a B-tree data structure. MongoDB can use these representation of the data to optimize query responses.
- Every query, including update operations, use one and only one index. The *query optimizer* (page 118) selects the index empirically by occasionally running alternate query plans and by selecting the plan with the best response time for each query type. You can override the query optimizer using the `cursor.hint()` (page 806) method.
- An index "covers" a query if:
  - all the fields in the *query* (page 112) are part of that index, **and**
  - all the fields returned in the documents that match the query are in the same index.

  When an index covers a query, the server can both match the *query conditions* (page 112) **and** return the results using only the index; MongoDB does not need to look at the documents, only the index, to fulfill the query. Querying the index can be faster than querying the documents outside of the index.

  See *Create Indexes that Support Covered Queries* (page 258) for more information.

- Using queries with good index coverage reduces the number of full documents that MongoDB needs to store in memory, thus maximizing database performance and throughput.
- If an update does not change the size of a document or cause the document to outgrow its allocated area, then MongoDB will update an index *only if* the indexed fields have changed. This improves performance. Note that if the document has grown and must move, all index keys must then update.

24.2 Index Types

This section enumerates the types of indexes available in MongoDB. For all collections, MongoDB creates the default *_id index* (page 242). You can create additional indexes with the `ensureIndex()` (page 819) method on any single field or *sequence of fields* (page 243) within any document or *sub-document* (page 243). MongoDB also supports indexes of arrays, called *multi-key indexes* (page 244).

24.2.1 _id Index

The `_id` index is a *unique index* (page 246) [1] on the `_id` field, and MongoDB creates this index by default on all collections. [2] You cannot delete the index on `_id`.

The `_id` field is the *primary key* for the collection, and every document *must* have a unique `_id` field. You may store any unique value in the `_id` field. The default value of `_id` is *ObjectID* on every insert() <db.collection.insert()‘ operation. An *ObjectId* is a 12-byte unique identifiers suitable for use as the value of an `_id` field.

Note: In *sharded clusters*, if you do *not* use the `_id` field as the *shard key*, then your application **must** ensure the uniqueness of the values in the `_id` field to prevent errors. This is most-often done by using a standard auto-generated *ObjectId*.

24.2.2 Secondary Indexes

All indexes in MongoDB are *secondary indexes*. You can create indexes on any field within any document or sub-document. Additionally, you can create compound indexes with multiple fields, so that a single query can match multiple components using the index while scanning fewer whole documents.

In general, you should create indexes that support your primary, common, and user-facing queries. Doing so requires MongoDB to scan the fewest number of documents possible.

In the `mongo` (page 908) shell, you can create an index by calling the `ensureIndex()` (page 819) method. Arguments to `ensureIndex()` (page 819) resemble the following:

```
{ "field": 1 }
{ "product.quantity": 1 }
{ "product": 1, "quantity": 1 }
```

For each field in the index specify either `1` for an ascending order or `-1` for a descending order, which represents the order of the keys in the index. For indexes with more than one key (i.e. *compound indexes* (page 243)) the sequence of fields is important.

[1] Although the index on `_id` *is* unique, the `getIndexes()` (page 826) method will *not* print `unique: true` in the `mongo` (page 908) shell.

[2] Before version 2.2 capped collections did not have an `_id` field. In 2.2, all capped collections have an `_id` field, except those in the `local` *database*. See the *release notes* (page 1042) for more information.

24.2.3 Indexes on Sub-documents

You can create indexes on fields that hold sub-documents as in the following example:

Example

Given the following document in the `factories` collection:

```
{ "_id": ObjectId(...), metro: { city: "New York", state: "NY" } } )
```

You can create an index on the `metro` key. The following queries would then use that index, and both would return the above document:

```
db.factories.find( { metro: { city: "New York", state: "NY" } } );
```

```
db.factories.find( { metro: { $gte : { city: "New York" } } } );
```

The second query returns the document because `{ city: "New York" }` is less than `{ city: "New York", state: "NY" }` The order of comparison is in ascending key order in the order the keys occur in the *BSON* document.

24.2.4 Indexes on Embedded Fields

You can create indexes on fields in sub-documents, just as you can index top-level fields in documents. [3] These indexes allow you to use a "dot notation," to introspect into sub-documents.

Consider a collection named `people` that holds documents that resemble the following example document:

```
{"_id": ObjectId(...)
 "name": "John Doe"
 "address": {
        "street": "Main"
        "zipcode": 53511
        "state": "WI"
        }
}
```

You can create an index on the `address.zipcode` field, using the following specification:

```
db.people.ensureIndex( { "address.zipcode": 1 } )
```

24.2.5 Compound Indexes

MongoDB supports "compound indexes," where a single index structure holds references to multiple fields within a collection's documents. Consider a collection named `products` that holds documents that resemble the following document:

```
{
 "_id": ObjectId(...)
 "item": "Banana"
 "category": ["food", "produce", "grocery"]
 "location": "4th Street Store"
 "stock": 4
```

[3] *Indexes on Sub-documents* (page 243), by contrast allow you to index fields that hold documents, including the full content, up to the maximum `Index Size` (page 1022) of the sub-document in the index.

```
 "type": cases
 "arrival": Date(...)
}
```

If most applications queries include the `item` field and a significant number of queries will also check the `stock` field, you can specify a single compound index to support both of these queries:

```
db.products.ensureIndex( { "item": 1, "location": 1, "stock": 1 } )
```

Compound indexes support queries on any prefix of the fields in the index. [4] For example, MongoDB can use the above index to support queries that select the `item` field and to support queries that select the `item` field **and** the `location` field. The index, however, would not support queries that select the following:

- only the `location` field
- only the `stock` field
- only the `location` and `stock` fields
- only the `item` and `stock` fields

When creating an index, the number associated with a key specifies the direction of the index. The options are `1` (ascending) and `-1` (descending). Direction doesn't matter for single key indexes or for random access retrieval but is important if you are doing sort queries on compound indexes.

The order of fields in a compound index is very important. In the previous example, the index will contain references to documents sorted first by the values of the `item` field and, within each value of the `item` field, sorted by the values of `location`, and then sorted by values of the `stock` field.

24.2.6 Indexes with Ascending and Descending Keys

Indexes store references to fields in either ascending or descending order. For single-field indexes, the order of keys doesn't matter, because MongoDB can traverse the index in either direction. However, for *compound indexes* (page 243), if you need to order results against two fields, sometimes you need the index fields running in opposite order relative to each other.

To specify an index with a descending order, use the following form:

```
db.products.ensureIndex( { "field": -1 } )
```

More typically in the context of a *compound index* (page 243), the specification would resemble the following prototype:

```
db.products.ensureIndex( { "fieldA": 1, "fieldB": -1 } )
```

Consider a collection of event data that includes both usernames and a timestamp. If you want to return a list of events sorted by username and then with the most recent events first. To create this index, use the following command:

```
db.events.ensureIndex( { "username" : 1, "timestamp" : -1 } )
```

24.2.7 Multikey Indexes

If you index a field that contains an array, MongoDB indexes each value in the array separately, in a "multikey index."

Example

[4] Index prefixes are the beginning subset of fields. For example, given the index `{ a: 1, b: 1, c: 1 }` both `{ a: 1 }` and `{ a: 1, b: 1 }` are prefixes of the index.

Given the following document:

```
{ "_id" : ObjectId("..."),
  "name" : "Warm Weather",
  "author" : "Steve",
  "tags" : [ "weather", "hot", "record", "april" ] }
```

Then an index on the `tags` field would be a multikey index and would include these separate entries:

```
{ tags: "weather" }
{ tags: "hot" }
{ tags: "record" }
{ tags: "april" }
```

Queries could use the multikey index to return queries for any of the above values.

You can use multikey indexes to index fields within objects embedded in arrays, as in the following example:

Example

Consider a `feedback` collection with documents in the following form:

```
{
 "_id": ObjectId(...)
 "title": "Grocery Quality"
 "comments": [
    { author_id: ObjectId(...)
      date: Date(...)
      text: "Please expand the cheddar selection." },
    { author_id: ObjectId(...)
      date: Date(...)
      text: "Please expand the mustard selection." },
    { author_id: ObjectId(...)
      date: Date(...)
      text: "Please expand the olive selection." }
 ]
}
```

An index on the `comments.text` field would be a multikey index and would add items to the index for all of the sub-documents in the array.

With an index, such as `{ comments.text: 1 }` you, consider the following query:

```
db.feedback.find( { "comments.text": "Please expand the olive selection." } )
```

This would select the document, that contains the following document in the `comments.text` array:

```
{ author_id: ObjectId(...)
  date: Date(...)
  text: "Please expand the olive selection." }
```

Compound Multikey Indexes May Only Include One Array Field

While you can create multikey *compound indexes* (page 243), at most one field in a compound index may hold an array. For example, given an index on `{ a: 1, b: 1 }`, the following documents are permissible:

```
{a: [1, 2], b: 1}
```

```
{a: 1, b: [1, 2]}
```

However, the following document is impermissible, and MongoDB cannot insert such a document into a collection with the `{a: 1, b: 1}` index:

```
{a: [1, 2], b: [1, 2]}
```

If you attempt to insert a such a document, MongoDB will reject the insertion, and produce an error that says `cannot index parallel arrays`. MongoDB does not index parallel arrays because they require the index to include each value in the Cartesian product of the compound keys, which could quickly result in incredibly large and difficult to maintain indexes.

24.2.8 Unique Indexes

A unique index causes MongoDB to reject all documents that contain a duplicate value for the indexed field. To create a unique index on the `user_id` field of the `members` collection, use the following operation in the `mongo` (page 908) shell:

```
db.addresses.ensureIndex( { "user_id": 1 }, { unique: true } )
```

By default, `unique` is `false` on MongoDB indexes.

If you use the unique constraint on a *compound index* (page 243) then MongoDB will enforce uniqueness on the *combination* of values, rather than the individual value for any or all values of the key.

If a document does not have a value for the indexed field in a unique index, the index will store a null value for this document. MongoDB will only permit one document without a unique value in the collection because of this unique constraint. You can combine with the *sparse index* (page 246) to filter these null values from the unique index.

24.2.9 Sparse Indexes

Sparse indexes only contain entries for documents that have the indexed field. [5] Any document that is missing the field is not indexed. The index is "sparse" because of the missing documents when values are missing.

By contrast, non-sparse indexes contain all documents in a collection, and store null values for documents that do not contain the indexed field. Create a sparse index on the `xmpp_id` field, of the `members` collection, using the following operation in the `mongo` (page 908) shell:

```
db.addresses.ensureIndex( { "xmpp_id": 1 }, { sparse: true } )
```

By default, `sparse` is `false` on MongoDB indexes.

Warning: Using these indexes will sometimes result in incomplete results when filtering or sorting results, because sparse indexes are not complete for all documents in a collection.

Note: Do not confuse sparse indexes in MongoDB with block-level indexes in other databases. Think of them as dense indexes with a specific filter.

You can combine the sparse index option with the *unique indexes* (page 246) option so that `mongod` (page 897) will reject documents that have duplicate values for a field, but that ignore documents that do not have the key.

[5] All documents that have the indexed field *are* indexed in a sparse index, even if that field stores a null value in some documents.

24.3 Index Creation Options

You specify index creation options in the second argument in `ensureIndex()` (page 819).

The options *sparse* (page 246), *unique* (page 246), and *TTL* (page 248) affect the kind of index that MongoDB creates. This section addresses, *background construction* (page 247) and *duplicate dropping* (page 248), which affect how MongoDB builds the indexes.

24.3.1 Background Construction

By default, creating an index is a blocking operation. Building an index on a large collection of data can take a long time to complete. To resolve this issue, the background option can allow you to continue to use your `mongod` (page 897) instance during the index build.

For example, to create an index in the background of the `zipcode` field of the `people` collection you would issue the following:

```
db.people.ensureIndex( { zipcode: 1}, {background: true} )
```

By default, `background` is `false` for building MongoDB indexes.

You can combine the background option with other options, as in the following:

```
db.people.ensureIndex( { zipcode: 1}, {background: true, sparse: true } )
```

Be aware of the following behaviors with background index construction:

- A `mongod` (page 897) instance can only build one background index per database, at a time. Changed in version 2.2: Before 2.2, a single `mongod` (page 897) instance could only build one index at a time.
- The indexing operation runs in the background so that other database operations can run while creating the index. However, the `mongo` (page 908) shell session or connection where you are creating the index will block until the index build is complete. Open another connection or `mongo` (page 908) instance to continue using commands to the database.
- The background index operation use an incremental approach that is slower than the normal "foreground" index builds. If the index is larger than the available RAM, then the incremental process can take *much* longer than the foreground build.
- If your application includes `ensureIndex()` (page 819) operations, and an index *doesn't* exist for other operational concerns, building the index can have a severe impact on the performance of the database.

  Make sure that your application checks for the indexes at start up using the `getIndexes()` (page 826) method or the equivalent method for your driver and terminates if the proper indexes do not exist. Always build indexes in production instances using separate application code, during designated maintenance windows.

Building Indexes on Secondaries

Background index operations on a *replica set primary* become foreground indexing operations on secondary members of the set. All indexing operations on secondaries block replication.

To build large indexes on secondaries the best approach is to restart one secondary at a time in *standalone* mode and build the index. After building the index, restart as a member of the replica set, allow it to catch up with the other members of the set, and then build the index on the next secondary. When all the secondaries have the new index, step down the primary, restart it as a standalone, and build the index on the former primary.

Remember, the amount of time required to build the index on a secondary node must be within the window of the *oplog*, so that the secondary can catch up with the primary.

See *Build Indexes on Replica Sets* (page 255) for more information on this process.

Indexes on secondary members in "recovering" mode are always built in the foreground to allow them to catch up as soon as possible.

See *Build Indexes on Replica Sets* (page 255) for a complete procedure for rebuilding indexes on secondaries.

Note: If MongoDB is building an index in the background, you cannot perform other administrative operations involving that collection, including `repairDatabase` (page 787), drop that collection (i.e. `db.collection.drop()` (page 818),) and `compact` (page 746). These operations will return an error during background index builds.

Queries will not use these indexes until the index build is complete.

24.3.2 Drop Duplicates

MongoDB cannot create a *unique index* (page 246) on a field that has duplicate values. To force the creation of a unique index, you can specify the `dropDups` option, which will only index the first occurrence of a value for the key, and delete all subsequent values.

Warning: As in all unique indexes, if a document does not have the indexed field, MongoDB will include it in the index with a "null" value.
If subsequent fields *do not* have the indexed field, and you have set `{dropDups: true}`, MongoDB will remove these documents from the collection when creating the index. If you combine `dropDups` with the *sparse* (page 246) option, this index will only include documents in the index that have the value, and the documents without the field will remain in the database.

To create a unique index that drops duplicates on the `username` field of the `accounts` collection, use a command in the following form:

```
db.accounts.ensureIndex( { username: 1 }, { unique: true, dropDups: true } )
```

Warning: Specifying `{ dropDups: true }` will delete data from your database. Use with extreme caution.

By default, `dropDups` is `false`.

24.4 Index Features

24.4.1 TTL Indexes

TTL indexes are special indexes that MongoDB can use to automatically remove documents from a collection after a certain amount of time. This is ideal for some types of information like machine generated event data, logs, and session information that only need to persist in a database for a limited amount of time.

These indexes have the following limitations:

- *Compound indexes* (page 243) are *not* supported.
- The indexed field **must** be a date *type*.
- If the field holds an array, and there are multiple date-typed data in the index, the document will expire when the *lowest* (i.e. earliest) matches the expiration threshold.

Note: TTL indexes expire data by removing documents in a background task that runs once a minute. As a result, the TTL index provides no guarantees that expired documents will not exist in the collection. Consider that:

- Documents may remain in a collection *after* they expire and before the background process runs.
- The duration of the removal operations depend on the workload of your `mongod` (page 897) instance.

In all other respects, TTL indexes are normal indexes, and if appropriate, MongoDB can use these indexes to fulfill arbitrary queries.

See Also:

Expire Data from Collections by Setting TTL (page 458)

24.4.2 Geospatial Indexes

MongoDB provides "geospatial indexes" to support location-based and other similar queries in a two dimensional coordinate systems. For example, use geospatial indexes when you need to take a collection of documents that have coordinates, and return a number of options that are "near" a given coordinate pair.

To create a geospatial index, your *documents* must have a coordinate pair. For maximum compatibility, these coordinate pairs should be in the form of a two element array, such as `[ x , y ]`. Given the field of `loc`, that held a coordinate pair, in the collection `places`, you would create a geospatial index as follows:

```
db.places.ensureIndex( { loc : "2d" } )
```

MongoDB will reject documents that have values in the `loc` field beyond the minimum and maximum values.

Note: MongoDB permits only one geospatial index per collection. Although, MongoDB will allow clients to create multiple geospatial indexes, a single query can use only one index.

See the `$near` (page 704), and the database command `geoNear` (page 765) for more information on accessing geospatial data.

24.4.3 Geohaystack Indexes

In addition to conventional *geospatial indexes* (page 249), MongoDB also provides a bucket-based geospatial index, called "geospatial haystack indexes." These indexes support high performance queries for locations within a small area, when the query must filter along another dimension.

Example

If you need to return all documents that have coordinates within 25 miles of a given point *and* have a type field value of "museum," a haystack index would be provide the best support for these queries.

Haystack indexes allow you to tune your bucket size to the distribution of your data, so that in general you search only very small regions of 2d space for a particular kind of document. These indexes are not suited for finding the closest documents to a particular location, when the closest documents are far away compared to bucket size.

24.5 Index Behaviors and Limitations

Be aware of the following behaviors and limitations:

- A collection may have no more than *64 indexes* (page 1022).
- Index keys can be no larger than *1024 bytes* (page 1022).

  Documents with fields that have values greater than this size cannot be indexed.

  To query for documents that were too large to index, you can use a command similar to the following:

  ```
  db.myCollection.find({<key>: <value too large to index>}).hint({$natural: 1})
  ```

- The name of an index, including the *namespace* must be shorter than *128 characters* (page 1022).
- Indexes have storage requirements, and impacts insert/update speed to some degree.
- Create indexes to support queries and other operations, but do not maintain indexes that your MongoDB instance cannot or will not use.
- For queries with the `$or` (page 707) operator, each clause of an `$or` (page 707) query executes in parallel, and can each use a different index.
- For queries that use the `sort()` (page 813) method and use the `$or` (page 707) operator, the query **cannot** use the indexes on the `$or` (page 707) fields.
- `2d` *geospatial queries* (page 269) do not support queries that use the `$or` (page 707) operator.

CHAPTER 25

Indexing Operations

This document provides operational guidelines and procedures for indexing data in MongoDB collections. For the fundamentals of MongoDB indexing, see the *Indexing Overview* (page 241) document. For strategies and practical approaches, see the *Indexing Strategies* (page 257) document.

Indexes allow MongoDB to process and fulfill queries quickly by creating small and efficient representations of the documents in a collection.

25.1 Create an Index

To create an index, use `db.collection.ensureIndex()` (page 819) or a similar method from your driver. For example the following creates an index on the `phone-number` field of the `people` collection:

```
db.people.ensureIndex( { "phone-number": 1 } )
```

`ensureIndex()` (page 819) only creates an index if an index of the same specification does not already exist.

All indexes support and optimize the performance for queries that select on this field. For queries that cannot use an index, MongoDB must scan all documents in a collection for documents that match the query.

Example

If you create an index on the `user_id` field in the `records`, this index is, the index will support the following query:

```
db.records.find( { user_id: 2 } )
```

However, the following query, on the `profile_url` field is not supported by this index:

```
db.records.find( { profile_url: 2 } )
```

If your collection holds a large amount of data, consider building the index in the background, as described in *Background Construction* (page 247). To build indexes on replica sets, see the *Build Indexes on Replica Sets* (page 255) section for more information.

25.2 Create a Compound Index

To create a *compound index* (page 243) use an operation that resembles the following prototype:

```
db.collection.ensureIndex( { a: 1, b: 1, c: 1 } )
```

For example, the following operation will create an index on the `item`, `category`, and `price` fields of the `products` collection:

```
db.products.ensureIndex( { item: 1, category: 1, price: 1 } )
```

Some drivers may specify indexes, using `NumberLong(1)` rather than `1` as the specification. This does not have any affect on the resulting index.

Note: To build or rebuild indexes for a *replica set* see *Build Indexes on Replica Sets* (page 255).

If your collection is large, build the index in the background, as described in *Background Construction* (page 247). If you build in the background on a live replica set, see also *Build Indexes on Replica Sets* (page 255).

25.3 Special Creation Options

Note: TTL collections use a special `expire` index option. See *Expire Data from Collections by Setting TTL* (page 458) for more information.

Note: To create geospatial indexes, see *Create a Geospatial Index* (page 269).

25.3.1 Sparse Indexes

To create a *sparse index* (page 246) on a field, use an operation that resembles the following prototype:

```
db.collection.ensureIndex( { a: 1 }, { sparse: true } )
```

The following example creates a sparse index on the `users` table that *only* indexes the `twitter_name` *if* a document has this field. This index will not include documents in this collection without the `twitter_name` field.

```
db.users.ensureIndex( { twitter_name: 1 }, { sparse: true } )
```

Note: Sparse indexes can affect the results returned by the query, particularly with respect to sorts on fields *not* included in the index. See the *sparse index* (page 246) section for more information.

25.3.2 Unique Indexes

To create a *unique indexes* (page 246), consider the following prototype:

```
db.collection.ensureIndex( { a: 1 }, { unique: true } )
```

For example, you may want to create a unique index on the `"tax-id":` of the `accounts` collection to prevent storing multiple account records for the same legal entity:

```
db.accounts.ensureIndex( { "tax-id": 1 }, { unique: true } )
```

The *_id index* (page 242) is a unique index. In some situations you may consider using `_id` field itself for this kind of data rather than using a unique index on another field.

In many situations you will want to combine the `unique` constraint with the `sparse` option. When MongoDB indexes a field, if a document does not have a value for a field, the index entry for that item will be `null`. Since unique indexes cannot have duplicate values for a field, without the `sparse` option, MongoDB will reject the second document and all subsequent documents without the indexed field. Consider the following prototype.

```
db.collection.ensureIndex( { a: 1 }, { unique: true, sparse: true } )
```

You can also enforce a unique constraint on *compound indexes* (page 243), as in the following prototype:

```
db.collection.ensureIndex( { a: 1, b: 1 }, { unique: true } )
```

These indexes enforce uniqueness for the *combination* of index keys and *not* for either key individually.

25.3.3 Create in Background

To create an index in the background you can specify *background construction* (page 247). Consider the following prototype invocation of `db.collection.ensureIndex()` (page 819):

```
db.collection.ensureIndex( { a: 1 }, { background: true } )
```

Consider the section on *background index construction* (page 247) for more information about these indexes and their implications.

25.3.4 Drop Duplicates

To force the creation of a *unique index* (page 246) index on a collection with duplicate values in the field you are indexing you can use the `dropDups` option. This will force MongoDB to create a *unique* index by deleting documents with duplicate values when building the index. Consider the following prototype invocation of `db.collection.ensureIndex()` (page 819):

```
db.collection.ensureIndex( { a: 1 }, { dropDups: true } )
```

See the full documentation of *duplicate dropping* (page 248) for more information.

> **Warning:** Specifying `{ dropDups: true }` may delete data from your database. Use with extreme caution.

Refer to the `ensureIndex()` (page 819) documentation for additional index creation options.

25.4 Information about Indexes

25.4.1 List all Indexes on a Collection

To return a list of all indexes on a collection, use the, use the `db.collection.getIndexes()` (page 826) method or a similar method for your driver.

For example, to view all indexes on the `people` collection:

```
db.people.getIndexes()
```

25.4.2 List all Indexes for a Database

To return a list of all indexes on all collections in a database, use the following operation in the `mongo` (page 908) shell:

```
db.system.indexes.find()
```

25.4.3 Measure Index Use

Query performance is a good general indicator of index use; however, for more precise insight into index use, MongoDB provides the following tools:

- `explain()` (page 805)

  Append the `explain()` (page 805) method to any cursor (e.g. query) to return a document with statistics about the query process, including the index used, the number of documents scanned, and the time the query takes to process in milliseconds.

- `cursor.hint()` (page 806)

  Append the `hint()` (page 806) to any cursor (e.g. query) with the index as the argument to *force* MongoDB to use a specific index to fulfill the query. Consider the following example:

  ```
  db.people.find( { name: "John Doe", zipcode: { $gt: 63000 } } ).hint( { zipcode: 1 } )
  ```

  You can use `hint()` (page 806) and `explain()` (page 805) in conjunction with each other to compare the effectiveness of a specific index. Specify the `$natural` operator to the `hint()` (page 806) method to prevent MongoDB from using *any* index:

  ```
  db.people.find( { name: "John Doe", zipcode: { $gt: 63000 } } ).hint( { $natural: 1 } )
  ```

- `indexCounters` (page 971)

  Use the `indexCounters` (page 971) data in the output of `serverStatus` (page 792) for insight into database-wise index utilization.

25.5 Remove Indexes

To remove an index, use the `db.collection.dropIndex()` (page 818) method, as in the following example:

```
db.accounts.dropIndex( { "tax-id": 1 } )
```

This will remove the index on the `"tax-id"` field in the `accounts` collection. The shell provides the following document after completing the operation:

```
{ "nIndexesWas" : 3, "ok" : 1 }
```

Where the value of `nIndexesWas` reflects the number of indexes *before* removing this index. You can also use the `db.collection.dropIndexes()` (page 819) to remove *all* indexes, except for the *_id index* (page 242) from a collection.

These shell helpers provide wrappers around the `dropIndexes` (page 755) *database command*. Your *client library* (page 435) may have a different or additional interface for these operations.

25.6 Rebuild Indexes

If you need to rebuild indexes for a collection you can use the db.collection.reIndex() (page 838) method. This will drop all indexes, including the *_id index* (page 242), and then rebuild all indexes. The operation takes the following form:

```
db.accounts.reIndex()
```

MongoDB will return the following document when the operation completes:

```
{
        "nIndexesWas" : 2,
        "msg" : "indexes dropped for collection",
        "nIndexes" : 2,
        "indexes" : [
                {
                        "key" : {
                                "_id" : 1,
                                "tax-id" : 1
                        },
                        "ns" : "records.accounts",
                        "name" : "_id_"
                }
        ],
        "ok" : 1
}
```

This shell helper provides a wrapper around the reIndex (page 784) *database command*. Your *client library* (page 435) may have a different or additional interface for this operation.

Note: To build or rebuild indexes for a *replica set* see *Build Indexes on Replica Sets* (page 255).

25.7 Build Indexes on Replica Sets

Background index creation operations (page 247) become *foreground* indexing operations on *secondary* members of replica sets. The foreground index building process blocks all replication and read operations on the secondaries while they build the index.

Secondaries will begin building indexes *after* the *primary* finishes building the index. In *sharded clusters*, the mongos (page 905) will send ensureIndex() (page 819) to the primary members of the replica set for each shard, which then replicate to the secondaries after the primary finishes building the index.

To minimize the impact of building an index on your replica set, use the following procedure to build indexes on secondaries:

Note: If you need to build an index in a *sharded cluster*, repeat the following procedure for each replica set that provides each *shard*.

---

1. Stop the mongod (page 897) process on one secondary. Restart the mongod (page 897) process *without* the *--replSet* (page 903) option and running on a different port. [1] This instance is now in "standalone" mode.
2. Create the new index or rebuild the index on this mongod (page 897) instance.

[1] By running the mongod (page 897) on a different port, you ensure that the other members of the replica set and all clients will not contact the member while you are building the index.

3. Restart the mongod (page 897) instance with the --replSet (page 903) option. Allow replication to catch up on this member.
4. Repeat this operation on all of the remaining secondaries.
5. Run rs.stepDown() (page 862) on the *primary* member of the set, and then repeat this procedure on the former primary.

Warning: Ensure that your *oplog* is large enough to permit the indexing or re-indexing operation to complete without falling too far behind to catch up. See the "*oplog sizing* (page 282)" documentation for additional information.

Note: This procedure *does* take one member out of the replica set at a time. However, this procedure will only affect one member of the set at a time rather than *all* secondaries at the same time.

25.8 Monitor and Control Index Building

To see the status of the indexing processes, you can use the db.currentOp() (page 846) method in the mongo (page 908) shell. The value of the query field and the msg field will indicate if the operation is an index build. The msg field also indicates the percent of the build that is complete.

You can only terminate a background index build. If you need to terminate an ongoing index build, You can use the db.killOp() (page 851) method in the mongo (page 908) shell.

CHAPTER 26

Indexing Strategies

This document provides strategies for indexing in MongoDB. For fundamentals of MongoDB indexing, see *Indexing Overview* (page 241). For operational guidelines and procedures, see *Indexing Operations* (page 251).

26.1 Strategies

The best indexes for your application are based on a number of factors, including the kinds of queries you expect, the ratio of reads to writes, and the amount of free memory on your system.

When developing your indexing strategy you should have a deep understanding of:

- The application's queries.
- The relative frequency of each query in the application.
- The current indexes created for your collections.
- Which indexes the most common queries use.

The best overall strategy for designing indexes is to profile a variety of index configurations with data sets similar to the ones you'll be running in production to see which configurations perform best.

MongoDB can only use *one* index to support any given operation. However, each clause of an `$or` (page 707) query may use a different index.

26.2 Create Indexes to Support Your Queries

If you only ever query on a single key in a given collection, then you need to create just one single-key index for that collection. For example, you might create an index on `category` in the `product` collection:

```
db.products.ensureIndex( { "category": 1 } )
```

However, if you sometimes query on only one key and at other times query on that key combined with a second key, then creating a *compound index* (page 243) is more efficient. MongoDB will use the compound index for both queries. For example, you might create an index on both `category` and `item`.

```
db.products.ensureIndex( { "category": 1, "item": 1 } )
```

This allows you both options. You can query on just `category`, and you also can query on `category` combined with `item`. (To query on multiple keys and sort the results, see *Use Indexes to Sort Query Results* (page 259).)

With the exception of queries that use the `$or` (page 707) operator, a query does not use multiple indexes. A query uses only one index.

26.3 Use Compound Indexes to Support Several Different Queries

A single *compound index* (page 243) on multiple fields can support all the queries that search a "prefix" subset of those fields.

Example

The following index on a collection:

```
{ x: 1, y: 1, z: 1 }
```

Can support queries that the following indexes support:

```
{ x: 1 }
{ x: 1, y: 1 }
```

There are some situations where the prefix indexes may offer better query performance: for example if `z` is a large array.

The `{ x: 1, y: 1, z: 1 }` index can also support many of the same queries as the following index:

```
{ x: 1, z: 1 }
```

Also, `{ x: 1, z: 1 }` has an additional use. Given the following query:

```
db.collection.find( { x: 5 } ).sort( { z: 1} )
```

The `{ x: 1, z: 1 }` index supports both the query and the sort operation, while the `{ x: 1, y: 1, z: 1 }` index only supports the query. For more information on sorting, see *Use Indexes to Sort Query Results* (page 259).

26.4 Create Indexes that Support Covered Queries

A covered query is a query in which:

- all the fields in the *query* (page 112) are part of an index, **and**
- all the fields returned in the results are in the same index.

Because the index "covers" the query, MongoDB can both match the *query conditions* (page 112) **and** return the results using only the index; MongoDB does not need to look at the documents, only the index, to fulfill the query.

Querying *only* the index can be much faster than querying documents outside of the index. Index keys are typically smaller than the documents they catalog, and indexes are typically available in RAM or located sequentially on disk.

MongoDB automatically uses an index that covers a query when possible. To ensure that an index can *cover* a query, create an index that includes all the fields listed in the *query document* (page 112) and in the query result. You can specify the fields to return in the query results with a *projection* (page 115) document. By default, MongoDB includes the `_id` field in the query result. So, if the index does **not** include the `_id` field, then you must exclude the `_id` field (i.e. `_id: 0`) from the query results.

Consider the following example where the collection `user` has an index on the fields `user` and `status`:

```
{ status: 1, user: 1 }
```

Then, the following query which queries on the `status` field and returns only the `user` field is covered:

```
db.users.find( { status: "A" }, { user: 1, _id: 0 } )
```

However, the following query that uses the index to match documents is **not** covered by the index because it returns both the `user` field **and** the `_id` field:

```
db.users.find( { status: "A" }, { user: 1 } )
```

An index **cannot** cover a query if:

- any of the indexed fields in any of the documents in the collection includes an array. If an indexed field is an array, the index becomes a *multi-key index* (page 244) index and cannot support a covered query.
- any of the indexed fields are fields in subdocuments. To index fields in subdocuments, use *dot notation*. For example, consider a collection `users` with documents of the following form:

  ```
  { _id: 1, user: { login: "tester" } }
  ```

  The collection has the following indexes:

  ```
  { user: 1 }
  ```

  ```
  { "user.login": 1 }
  ```

  The `{ user: 1 }` index covers the following query:

  ```
  db.users.find( { user: { login: "tester" } }, { user: 1, _id: 0 } )
  ```

  However, the `{ "user.login": 1 }` index does **not** cover the following query:

  ```
  db.users.find( { "user.login": "tester" }, { "user.login": 1, _id: 0 } )
  ```

  The query, however, does use the `{ "user.login": 1 }` index to find matching documents.

To determine whether a query is a covered query, use the `explain()` (page 805) method. If the `explain()` (page 805) output displays `true` for the `indexOnly` (page 1009) field, the query is covered by an index, and MongoDB queries only that index to match the query **and** return the results.

For more information see *Measure Index Use* (page 254).

26.5 Use Indexes to Sort Query Results

For the fastest performance when sorting query results by a given field, create a sorted index on that field.

To sort query results on multiple fields, create a *compound index* (page 243). MongoDB sorts results based on the field order in the index. For queries that include a sort that uses a compound index, ensure that all fields before the first sorted field are equality matches.

Example

If you create the following index:

```
{ a: 1, b: 1, c: 1, d: 1 }
```

The following query and sort operations can use the index:

```
db.collection.find().sort( { a:1 } )
db.collection.find().sort( { a:1, b:1 } )

db.collection.find( { a:4 } ).sort( { a:1, b:1 } )
db.collection.find( { b:5 } ).sort( { a:1, b:1 } )

db.collection.find( { a:5 } ).sort( { b:1, c:1 } )

db.collection.find( { a:5, c:4, b:3 } ).sort( { d:1 } )

db.collection.find( { a: { $gt:4 } } ).sort( { a:1, b:1 } )
db.collection.find( { a: { $gt:5 } } ).sort( { a:1, b:1 } )

db.collection.find( { a:5, b:3, d:{ $gt:4 } } ).sort( { c:1 } )
db.collection.find( { a:5, b:3, c:{ $lt:2 }, d:{ $gt:4 } } ).sort( { c:1 } )
```

However, the following queries cannot sort the results using the index:

```
db.collection.find().sort( { b:1 } )
db.collection.find( { b:5 } ).sort( { b:1 } )
```

Note: For in-memory sorts that do not use an index, the `sort()` (page 813) operation is significantly slower. The `sort()` (page 813) operation will abort when it uses 32 megabytes of memory.

26.6 Ensure Indexes Fit RAM

For the fastest processing, ensure that your indexes fit entirely in RAM so that the system can avoid reading the index from disk.

To check the size of your indexes, use the `db.collection.totalIndexSize()` (page 842) helper, which returns data in bytes:

```
> db.collection.totalIndexSize()
4294976499
```

The above example shows an index size of almost 4.3 gigabytes. To ensure this index fits in RAM, you must not only have more than that much RAM available but also must have RAM available for the rest of the *working set*. Also remember:

If you have and use multiple collections, you must consider the size of all indexes on all collections. The indexes and the working set must be able to fit in memory at the same time.

There are some limited cases where indexes do not need to fit in memory. See *Indexes that Hold Only Recent Values in RAM* (page 260).

See Also:

For additional *collection statistics* (page 980), use `collStats` (page 745) or `db.collection.stats()` (page 841).

26.6.1 Indexes that Hold Only Recent Values in RAM

Indexes do not have to fit *entirely* into RAM in all cases. If the value of the indexed field increments with every insert, and most queries select recently added documents; then MongoDB only needs to keep the parts of the index that hold

the most recent or "right-most" values in RAM. This allows for efficient index use for read and write operations and minimize the amount of RAM required to support the index.

26.7 Create Queries that Ensure Selectivity

Selectivity is the ability of a query to narrow results using the index. Effective indexes are more selective and allow MongoDB to use the index for a larger portion of the work associated with fulfilling the query.

To ensure selectivity, write queries that limit the number of possible documents with the indexed field. Write queries that are appropriately selective relative to your indexed data.

Example

Suppose you have a field called `status` where the possible values are `new` and `processed`. If you add an index on `status` you've created a low-selectivity index. The index will be of little help in locating records.

A better strategy, depending on your queries, would be to create a *compound index* (page 243) that includes the low-selectivity field and another field. For example, you could create a compound index on `status` and `created_at`.

Another option, again depending on your use case, might be to use separate collections, one for each status.

Example

Consider an index `{ a : 1 }` (i.e. an index on the key `a` sorted in ascending order) on a collection where `a` has three values evenly distributed across the collection:

```
{ _id: ObjectId(), a: 1, b: "ab" }
{ _id: ObjectId(), a: 1, b: "cd" }
{ _id: ObjectId(), a: 1, b: "ef" }
{ _id: ObjectId(), a: 2, b: "jk" }
{ _id: ObjectId(), a: 2, b: "lm" }
{ _id: ObjectId(), a: 2, b: "no" }
{ _id: ObjectId(), a: 3, b: "pq" }
{ _id: ObjectId(), a: 3, b: "rs" }
{ _id: ObjectId(), a: 3, b: "tv" }
```

If you query for `{ a: 2, b: "no" }` MongoDB must scan 3 *documents* in the collection to return the one matching result. Similarly, a query for `{ a: { $gt: 1}, b: "tv" }` must scan 6 documents, also to return one result.

Consider the same index on a collection where `a` has *nine* values evenly distributed across the collection:

```
{ _id: ObjectId(), a: 1, b: "ab" }
{ _id: ObjectId(), a: 2, b: "cd" }
{ _id: ObjectId(), a: 3, b: "ef" }
{ _id: ObjectId(), a: 4, b: "jk" }
{ _id: ObjectId(), a: 5, b: "lm" }
{ _id: ObjectId(), a: 6, b: "no" }
{ _id: ObjectId(), a: 7, b: "pq" }
{ _id: ObjectId(), a: 8, b: "rs" }
{ _id: ObjectId(), a: 9, b: "tv" }
```

If you query for `{ a: 2, b: "cd" }`, MongoDB must scan only one document to fulfill the query. The index and query are more selective because the values of `a` are evenly distributed *and* the query can select a specific document using the index.

However, although the index on `a` is more selective, a query such as `{ a: { $gt: 5 }, b: "tv" }` would still need to scan 4 documents.

If overall selectivity is low, and if MongoDB must read a number of documents to return results, then some queries may perform faster without indexes. To determine performance, see *Measure Index Use* (page 254).

26.8 Consider Performance when Creating Indexes for Write-heavy Applications

If your application is write-heavy, then be careful when creating new indexes, since each additional index with impose a write-performance penalty. In general, don't be careless about adding indexes. Add indexes to complement your queries. Always have a good reason for adding a new index, and be sure to benchmark alternative strategies.

26.8.1 Consider Insert Throughput

MongoDB must update *all* indexes associated with a collection after every insert, update, or delete operation. For update operations, if the updated document does not move to a new location, then MongoDB only modifies the updated fields in the index. Therefore, every index on a collection adds some amount of overhead to these write operations. In almost every case, the performance gains that indexes realize for read operations are worth the insertion penalty. However, in some cases:

- An index to support an infrequent query might incur more insert-related costs than savings in read-time.
- If you have many indexes on a collection with a high insert throughput and a number of related indexes, you may find better overall performance with a smaller number of indexes, even if some queries are less optimally supported by an index.
- If your indexes and queries are not sufficiently *selective* (page 261), the speed improvements for query operations may not offset the costs of maintaining an index. For more information see *Create Queries that Ensure Selectivity* (page 261).

CHAPTER 27

Geospatial Queries with 2d Indexes

MongoDB provides support for querying location-based data using special geospatial indexes. For an introduction to these 2d indexes, see *2d Geospatial Indexes* (page 269).

MongoDB supports the following geospatial query types:

- Proximity queries, which select documents based on distance to a given point. See *Proximity Queries* (page 263).
- Bounded queries, which select documents that have coordinates within a specified area. See *Bounded Queries* (page 265).
- Exact queries, which select documents with an exact coordinate pair, which has limited applicability. See *Query for Exact Matches* (page 266).

27.1 Proximity Queries

Proximity queries select the documents closest to the point specified in the query. To perform proximity queries you use either the find() (page 820) method with the $near (page 704) operator or you use the geoNear (page 765) command.

The find() (page 820) method with the $near (page 704) operator returns 100 documents by default and sorts the results by distance. The $near (page 704) operator uses the following form:

```
db.collection.find( { <location field>: { $near: [ x, y ] } } )
```

Example

The following query

```
db.places.find( { loc: { $near: [ -70, 40 ] } } )
```

returns output similar to the following:

```
{ "_id" : ObjectId(" ... "), "loc" : [ -73, 39 ] }
```

The geoNear (page 765) command returns more information than does the $near (page 704) operator. The geoNear (page 765) command can only return a single 16-megabyte result set. The geoNear (page 765) command also offers additional operators, such as operators to query for *maximum* (page 264) or *spherical* (page 266) distance. For a list of operators, see geoNear (page 765).

Without additional operators, the geoNear (page 765) command uses the following form:

```
db.runCommand( { geoNear: <collection>, near: [ x, y ] } )
```

Example

The following command returns the same results as the $near (page 704) in the previous example but with more information:

```
db.runCommand( { geoNear: "places", near: [ -74, 40.74 ] } )
```

This operation will return the following output:

```
{
   "ns" : "test.places",
   "results" : [
      {
         "dis" : 3,
         "obj" : {
            "_id" : ObjectId(" ... "),
            "loc" : [
               -73,
               39
            ]
         }
      }
   ],
   "stats" : {
      "time" : 2,
      "btreelocs" : 0,
      "nscanned" : 1,
      "objectsLoaded" : 1,
      "avgDistance" : 3,
      "maxDistance" : 3.0000188685220253
   },
   "near" : "0110000111111000000111111000000111111000000111111000",
   "ok" : 1
}
```

27.2 Distance Queries

You can limit a proximity query to those documents that fall within a maximum distance of a point. You specify the maximum distance using the units specified by the coordinate system. For example, if the coordinate system uses meters, you specify maximum distance in meters.

To specify distance using the find() (page 820) method, use $maxDistance (page 702) operator. Use the following form:

```
db.collection.find( { <location field> : { $near : [ x , y ] , $maxDistance : <distance> } } )
```

To specify distance with the geoNear (page 765) command, use the maxDistance option. Use the following form:

```
db.runCommand( { geoNear: <collection>, near: [ x, y ], maxDistance: <distance> } )
```

27.3 Limit the Number of Results

By default, geospatial queries using `find()` (page 820) method return 100 documents, sorted by distance. To limit the result when using the `find()` (page 820) method, use the `limit()` (page 807) method, as in the following prototype:

```
db.collection.find( { <location field>: { $near: [ x, y ] } } ).limit(<n>)
```

To limit the result set when using the `geoNear` (page 765) command, use the `num` option. Use the following form:

```
db.runCommand( { geoNear: <collection>, near: [ x, y ], num: z } )
```

To limit geospatial search results by distance, see *Distance Queries* (page 264).

27.3.1 Bounded Queries

Bounded queries return documents within a shape defined using the `$within` (page 721) operator. MongoDB's bounded queries support the following shapes:

- *Circles* (page 265)
- *Rectangles* (page 266)
- *Polygons* (page 266)

Bounded queries do not return sorted results. As a result MongoDB can return bounded queries more quickly than *proximity queries* (page 263). Bounded queries have the following form:

```
db.collection.find( { <location field> :
                            { "$within" :
                              { <shape> : <shape dimensions> }
                            }
                    } )
```

The following sections describe each of the shapes supported by bounded queries:

27.4 Circles

To query for documents with coordinates inside the bounds of a circle, specify the center and the radius of the circle using the `$within` (page 721) operator and `$center` (page 694) option. Consider the following prototype query:

```
db.collection.find( { "field": { "$within": { "$center": [ center, radius ] } } } )
```

The following example query returns all documents that have coordinates that exist within the circle centered on `[-74, 40.74]` and with a radius of `10`, using a geospatial index on the `loc` field:

```
db.places.find( { "loc": { "$within":
                             { "$center": [ [-74, 40.74], 10 ] }
                         }
                } )
```

The `$within` (page 721) operator using `$center` (page 694) is similar to using `$maxDistance` (page 702), but `$center` (page 694) has different performance characteristics. MongoDB does not sort queries that use the `$within` (page 721) operator are not sorted, unlike queries using the `$near` (page 704) operator.

27.5 Rectangles

To query for documents with coordinates inside the bounds of a rectangle, specify the lower-left and upper-right corners of the rectangle using the $within (page 721) operator and $box (page 693) option. Consider the following prototype query:

```
db.collection.find( { "field": { "$within": { "$box": [ coordinate0, coordinate1 ] } } } )
```

The following query returns all documents that have coordinates that exist within the rectangle where the lower-left corner is at [0, 0] and the upper-right corner is at [3, 3], using a geospatial index on the loc field:

```
db.places.find( { "loc": { "$within": { "$box": [ [0, 0] , [3, 3] ] } } } )
```

27.6 Polygons

New in version 1.9: Support for polygon queries. To query for documents with coordinates inside of a polygon, specify the points of the polygon in an array, using the $within (page 721) operator with the $polygon (page 709) option. MongoDB automatically connects the last point in the array to the first point. Consider the following prototype query:

```
db.places.find({ "loc": { "$within": { "$polygon": [ points ] } } })
```

The following query returns all documents that have coordinates that exist within the polygon defined by [[0,0], [3,3], [6,0]]:

```
db.places.find({ "loc": { "$within": { "$polygon":
                                    [ [ 0,0], [3,3], [6,0] ] } } } )
```

27.6.1 Query for Exact Matches

You can use the db.collection.find() (page 820) method to query for an exact match on a location. These queries have the following form:

```
db.collection.find( { <location field>: [ x, y ] } )
```

This query will return any documents with the value of [x, y].

Exact geospatial queries only applicability for a limited selection of cases, the *proximity* (page 263) and *bounded* (page 265) queries provide more useful results for more applications.

27.6.2 Calculate Distances Using Spherical Geometry

When you query using the 2d index, MongoDB calculates distances using flat geometry by default, which models points on a flat surface.

Optionally, you may instruct MongoDB to calculate distances using spherical geometry, which models points on a spherical surface. Spherical geometry is useful for modeling coordinates on the surface of Earth.

To calculate distances using spherical geometry, use MongoDB's spherical query operators and options:

- find() (page 820) method with the $nearSphere (page 705) operator.
- find() (page 820) method with the $centerSphere (page 694).
- geoNear (page 765) command with the { spherical: true } option.

See Also:

Geospatial (page 883).

For more information on differences between flat and spherical distance calculation, see *Distance Calculation* (page 272).

27.6.3 Distance Multiplier

The `distanceMultiplier` option `geoNear` (page 765) returns distances only after multiplying the results by command by an assigned value. This allows MongoDB to return converted values, and removes the requirement to convert units in application logic.

Note: Because `distanceMultiplier` is an option to `geoNear` (page 765), the multiplication operation occurs on the `mongod` (page 897) process. The operation adds a slight overhead to the operation of `geoNear` (page 765).

Using `distanceMultiplier` in spherical queries allows one to use results from the `geoNear` (page 765) command without radian to distance conversion. The following example uses `distanceMultiplier` in the `geoNear` (page 765) command with a *spherical* (page 266) example:

```
db.runCommand( { geoNear: "places",
                 near: [ -74, 40.74 ],
                 spherical: true,
                 distanceMultiplier: 3963.192
               }  )
```

The output of the above operation would resemble the following:

```
{
   // [ ... ]
   "results" : [
      {
         "dis" : 73.46525170413567,
         "obj" : {
            "_id" : ObjectId( ... )
            "loc" : [
               -73,
               40
            ]
         }
      }
   ],
   "stats" : {
      // [ ... ]
      "avgDistance" : 0.01853688938212826,
      "maxDistance" : 0.01853714811400047
   },
   "ok" : 1
}
```

See Also:

The *Distance operator* (page 264).

27.6.4 Querying Haystack Indexes

Haystack indexes are a special `2d` geospatial index that optimized to return results over small areas. To create geospatial indexes see *Haystack Indexes* (page 271).

To query the haystack index, use the `geoSearch` (page 765) command. You must specify both the coordinate and other field to `geoSearch` (page 765), which take the following form:

```
db.runCommand( { geoSearch: <collection>,
                 search: { <field>: <value> } } )
```

For example, to return all documents with the value `restaurants` in the `type` field near the example point, the command would resemble:

```
db.runCommand( { geoSearch: "places",
                 search: { type: "restaurant" },
                 near: [-74, 40.74] } )
```

Note: Haystack indexes are not suited to returning a full list of the closest documents to a particular location, as the closest documents could be far away compared to the `bucketSize`.

Note: *Spherical query operations* (page 266) are not currently supported by haystack indexes.

The `find()` (page 820) method and `geoNear` (page 765) command cannot access the haystack index.

CHAPTER 28

2d Geospatial Indexes

28.1 Overview

2d geospatial indexes make it possible to associate documents with locations in two-dimensional space, such as a point on a map. MongoDB interprets two-dimensional coordinates in a location field as points and can index these points in a special index type to support location-based queries. Geospatial indexes provide special geospatial query operators. For example, you can query for documents based on proximity to another location or based on inclusion in a specified region.

Geospatial indexes support queries on both the coordinate field *and* another field, such as a type of business or attraction. For example, you might write a query to find restaurants a specific distance from a hotel or to find museums within a certain defined neighborhood.

This document describes how to store location data in your documents and how to create geospatial indexes. For information on querying data stored in geospatial indexes, see *Geospatial Queries with 2d Indexes* (page 263).

28.2 Store Location Data

To use 2d geospatial indexes, you must model location data on a predetermined two-dimensional coordinate system, such as longitude and latitude. You store a document's location data as two coordinates in a field that holds either a two-dimensional array or an embedded document with two fields. Consider the following two examples:

```
loc : [ x, y ]
```

```
loc : { x: 1, y: 2 }
```

All documents must store location data in the same order. If you use latitude and longitude as your coordinate system, always store longitude first. MongoDB's *2d spherical index operators* (page 266) only recognize `[ longitude, latitude]` ordering.

28.3 Create a Geospatial Index

Important: MongoDB only supports *one* geospatial index per collection.

To create a geospatial index, use the ensureIndex (page 819) method with the value 2d for the location field of your collection. Consider the following prototype:

```
db.collection.ensureIndex( { <location field> : "2d" } )
```

MongoDB's *geospatial operations* (page 883) use this index when querying for location data.

When you create the index, MongoDB converts location data to binary *geohash* values and calculates these values using the location data and the index's location range, as described in *Location Range* (page 270). The default range for 2d indexes assumes longitude and latitude and uses the bounds -180 inclusive and 180 non-inclusive.

Important: The default boundaries of 2d indexes allow applications to insert documents with invalid latitudes greater than 90 or less than -90. The behavior of geospatial queries with such invalid points is not defined.

When creating a 2d index, MongoDB provides the following options:

28.3.1 Location Range

All 2d geospatial indexes have boundaries defined by a coordinate range. By default, 2d geospatial indexes assume longitude and latitude have boundaries of -180 inclusive and 180 non-inclusive (i.e. [-180, 180)). MongoDB returns an error and rejects documents with coordinate data outside of the specified range.

To build an index with a location range other than the default, use the min and max options with the ensureIndex() (page 819) operation when creating a 2d index, as in the following prototype:

```
db.collection.ensureIndex( { <location field>: "2d" } ,
                           { min: <lower bound> , max: <upper bound> } )
```

28.3.2 Location Precision

2d indexes use a *geohash* (page 273) representation of all coordinate data internally. Geohashes have a precision that is determined by the number of bits in the hash. More bits allow the index to provide results with greater precision, while fewer bits mean the index provides results with more limited precision.

Indexes with lower precision have a lower processing overhead for insert operations and will consume less space. However, higher precision indexes means that queries will need to scan smaller portions of the index to return results. The actual stored values are always used in the final query processing, and index precision does not affect query accuracy.

By default, geospatial indexes use 26 bits of precision, which is roughly equivalent to 2 feet or about 60 centimeters of precision using the default range of -180 to 180. You can configure 2d geospatial indexes with up to 32 bits of precision.

To configure a location precision other than the default, use the bits option in the ensureIndex() (page 819) method, as in the following prototype:

```
db.collection.ensureIndex( {<location field>: "2d"} ,
                           { bits: <bit precision> } )
```

For more information on the relationship between bits and precision, see *Geohash Values* (page 273).

28.3.3 Compound Geospatial Indexes

2d geospatial indexes may be *compound* (page 243), if and only if the field with location data is the first field. A compound geospatial index makes it possible to construct queries that primarily select on a location-based field but

also select on a second criteria. For example, you could use such an index to support queries for carpet wholesalers within a specific region.

Note: Geospatial queries will *only* use additional query parameters after applying the geospatial criteria. If your geospatial query criteria selects a large number of documents, the additional query will only filter the result set and *not* result in a more targeted query.

To create a geospatial index with two fields, specify the location field first, then the second field. For example, to create a compound index on the `loc` location field and on the `product` field (sorted in ascending order), you would issue the following:

```
db.storeInfo.ensureIndex( { loc: "2d", product: 1 } );
```

This creates an index that supports queries on just the location field (i.e. `loc`), as well as queries on both the `loc` and `product`.

28.3.4 Haystack Indexes

Haystack indexes create "buckets" of documents from the same geographic area in order to improve performance for queries limited to that area.

Each bucket in a haystack index contains all the documents within a specified proximity to a given longitude and latitude. Use the `bucketSize` parameter of `ensureIndex()` (page 819) to determine proximity. A `bucketSize` of `5` creates an index that groups location values that are within 5 units of the specified longitude and latitude.

`bucketSize` also determines the granularity of the index. You can tune the parameter to the distribution of your data so that in general you search only very small regions of a two-dimensional space. Furthermore, the areas defined by buckets can overlap. As a result a document can exist in multiple buckets.

To build a haystack index, use the `bucketSize` parameter in the `ensureIndex()` (page 819) method, as in the following prototype:

```
db.collection.ensureIndex({ <location field>: "geoHaystack", type: 1 },
                          { bucketSize: <bucket value> })
```

Example

Consider a collection with documents that contain fields similar to the following:

```
{ _id : 100, pos: { long : 126.9, lat : 35.2 }, type : "restaurant"}
{ _id : 200, pos: { long : 127.5, lat : 36.1 }, type : "restaurant"}
{ _id : 300, pos: { long : 128.0, lat : 36.7 }, type : "national park"}
```

The following operations creates a haystack index with buckets that store keys within 1 unit of longitude or latitude.

```
db.collection.ensureIndex( { pos : "geoHaystack", type : 1 }, { bucketSize : 1 } )
```

Therefore, this index stores the document with an `_id` field that has the value `200` in two different buckets:

1. in a bucket that includes the document where the `_id` field has a value of `100`, and
2. in a bucket that includes the document where the `_id` field has a value of `300`.

To query using a haystack index you use the `geoSearch` (page 765) command. For command details, see *Querying Haystack Indexes* (page 268).

Haystack indexes are ideal for returning documents based on location *and* an exact match on a *single* additional criteria. These indexes are not necessarily suited to returning the closest documents to a particular location.

Spherical queries (page 266) are not supported by geospatial haystack indexes.

By default, queries that use a haystack index return 50 documents.

28.4 Distance Calculation

MongoDB performs distance calculations before performing `2d` geospatial queries. By default, MongoDB uses flat geometry to calculate distances between points. MongoDB also supports distance calculations using spherical geometry, to provide accurate distances for geospatial information based on a sphere or earth.

Spherical Queries Use Radians for Distance

For spherical operators to function properly, you must convert distances to radians, and convert from radians to the distances units used by your application.

To convert:

- *distance to radians*: divide the distance by the radius of the sphere (e.g. the Earth) in the same units as the distance measurement.
- *radians to distance*: multiply the radian measure by the radius of the sphere (e.g. the Earth) in the units system that you want to convert the distance to.

The radius of the Earth is approximately `3963.192` miles or `6378.137` kilometers.

The following query would return documents from the `places` collection within the circle described by the center `[ -74, 40.74 ]` with a radius of `100` miles:

```
db.places.find( { loc: { $within: { $centerSphere: [ [ -74, 40.74 ] ,
                                                     100 / 3963.192 ] } } } )
```

You may also use the `distanceMultiplier` option to the `geoNear` (page 765) to convert radians in the `mongod` (page 897) process, rather than in your application code. Please see the *distance multiplier* (page 267) section.

The following spherical `2d` query, returns all documents in the collection `places` within `100` miles from the point `[ -74, 40.74 ]`.

```
db.runCommand( { geoNear: "places",
                 near: [ -74, 40.74 ],
                 spherical: true
               } )
```

The output of the above command would be:

```
{
   // [ ... ]
   "results" : [
      {
         "dis" : 0.01853688938212826,
         "obj" : {
            "_id" : ObjectId( ... )
            "loc" : [
               -73,
               40
            ]
         }
      }
   ],
```

```
   "stats" : {
      // [ ... ]
      "avgDistance" : 0.01853688938212826,
      "maxDistance" : 0.01853714811400047
   },
   "ok" : 1
}
```

Warning: Spherical queries that wrap around the poles or at the transition from `-180` to `180` longitude raise an error.

Note: While the default Earth-like bounds for geospatial indexes are between `-180` inclusive, and `180`, valid values for latitude are between `-90` and `90`.

28.5 Geohash Values

To create a geospatial index, MongoDB computes the *geohash* value for coordinate pairs within the specified *range* (page 270) and indexes the geohash for that point .

To calculate a geohash value, continuously divide a 2D map into quadrants. Then assign each quadrant a two-bit value. For example, a two-bit representation of four quadrants would be:

```
01  11

00  10
```

These two-bit values (`00`, `01`, `10`, and `11`) represent each of the quadrants and all points within each quadrant. For a geohash with two bits of resolution, all points in the bottom left quadrant would have a geohash of `00`. The top left quadrant would have the geohash of `01`. The bottom right and top right would have a geohash of `10` and `11`, respectively.

To provide additional precision, continue dividing each quadrant into sub-quadrants. Each sub-quadrant would have the geohash value of the containing quadrant concatenated with the value of the sub-quadrant. The geohash for the upper-right quadrant is `11`, and the geohash for the sub-quadrants would be (clockwise from the top left): `1101`, `1111`, `1110`, and `1100`, respectively.

To calculate a more precise geohash, continue dividing the sub-quadrant and concatenate the two-bit identifier for each division. The more "bits" in the hash identifier for a given point, the smaller possible area that the hash can describe and the higher the resolution of the geospatial index.

28.6 Geospatial Indexes and Sharding

You *cannot* use a geospatial index as a *shard key* when sharding a collection. However, you *can* create and maintain a geospatial index on a sharded collection by using a different field as the shard key. Your application may query for geospatial data using `geoNear` (page 765) and `$within` (page 721). However, queries using `$near` (page 704) are not supported for sharded collections.

28.7 Multi-location Documents

New in version 2.0: Support for multiple locations in a document. While `2d` indexes do not support more than one set of coordinates in a document, you can use a *multi-key indexes* (page 244) to store and index multiple coordinate pairs in a single document. In the simplest example you may have a field (e.g. `locs`) that holds an array of coordinates, as in the following prototype data model:

```
{
 "_id": ObjectId(...),
 "locs": [
           [ 55.5, 42.3 ],
           [ -74, 44.74 ],
           { "lat": 55.3, "long": 40.2 }
         ]
}
```

The values of the array may either be arrays holding coordinates, as in `[ 55.5, 42.3 ]`, or embedded documents, as in `{ "lat": 55.3, "long": 40.2 }`.

You could then create a geospatial index on the `locs` field, as in the following:

```
db.places.ensureIndex( { "locs": "2d" } )
```

You may also model the location data as a field inside of a sub-document. In this case, the document would contain a field (e.g. `addresses`) that holds an array of documents where each document has a field (e.g. `loc:`) that holds location coordinates. Consider the following prototype data model:

```
{
 "_id": ObjectId(...),
 "name": "...",
 "addresses": [
                {
                 "context": "home",
                 "loc": [ 55.5, 42.3 ]
                },
                {
                 "context": "home",
                 "loc": [ -74, 44.74 ]
                }
              ]
}
```

You could then create the geospatial index on the `addresses.loc` field as in the following example:

```
db.records.ensureIndex( { "addresses.loc": "2d" } )
```

For documents with multiple coordinate values, queries may return the same document multiple times if more than one indexed coordinate pair satisfies the query constraints. Use the `uniqueDocs` parameter to `geoNear` (page 765) or the `$uniqueDocs` (page 719) operator in conjunction with `$within` (page 721).

To include the location field with the distance field in multi-location document queries, specify `includeLocs: true` in the `geoNear` (page 765) command.

Part VII

Replication

Database replication ensures redundancy, backup, and automatic failover. Replication occurs through groups of servers known as replica sets.

For an overview, see *Replica Set Fundamental Concepts* (page 279). To work with members, see *Replica Set Operation and Management* (page 285). To configure deployment architecture, see *Replica Set Architectures and Deployment Patterns* (page 300). To modify read and write operations, see *Replica Set Considerations and Behaviors for Applications and Development* (page 303). For procedures for performing certain replication tasks, see the *list of replication tutorials* (page 323). For documentation of MongoDB's operational segregation capabilities for replica set deployments see the `http://docs.mongodb.org/v2.2/data-center-awareness`

This section contains full documentation, tutorials, and pragmatic guides, as well as links to the reference material that describes all aspects of replica sets.

CHAPTER 29

Replica Set Use and Operation

Consider these higher level introductions to replica sets:

29.1 Replica Set Fundamental Concepts

A MongoDB *replica set* is a cluster of `mongod` (page 897) instances that replicate amongst one another and ensure automated failover. Most replica sets consist of two or more `mongod` (page 897) instances with at most one of these designated as the primary and the rest as secondary members. Clients direct all writes to the primary, while the secondary members replicate from the primary asynchronously.

Database replication with MongoDB adds redundancy, helps to ensure high availability, simplifies certain administrative tasks such as backups, and may increase read capacity. Most production deployments use replication.

If you're familiar with other database systems, you may think about replica sets as a more sophisticated form of traditional master-slave replication. [1] In master-slave replication, a *master* node accepts writes while one or more *slave* nodes replicate those write operations and thus maintain data sets identical to the master. For MongoDB deployments, the member that accepts write operations is the **primary**, and the replicating members are **secondaries**.

MongoDB's replica sets provide automated failover. If a *primary* fails, the remaining members will automatically try to elect a new primary.

A replica set can have up to 12 members, but only 7 members can have votes. For information regarding non-voting members, see *non-voting members* (page 288)

See Also:

The *Replication* (page 277) index for a list of the documents in this manual that describe the operation and use of replica sets.

29.1.1 Member Configuration Properties

You can configure replica set members in a variety of ways, as listed here. In most cases, members of a replica set have the default proprieties.

[1] MongoDB also provides conventional master/slave replication. Master/slave replication operates by way of the same mechanism as replica sets, but lacks the automatic failover capabilities. While replica sets are the recommended solution for production, a replica set can support only 12 members in total. If your deployment requires more than 11 *slave* members, you'll need to use master/slave replication.

- **Secondary-Only**: These members have data but cannot become primary under any circumstance. See *Secondary-Only Members* (page 286).
- **Hidden**: These members are invisible to client applications. See *Hidden Members* (page 287).
- **Delayed**: These members apply operations from the primary's *oplog* after a specified delay. You can think of a delayed member as a form of "rolling backup." See *Delayed Members* (page 287).
- **Arbiters**: These members have no data and exist solely to participate in *elections* (page 280). See *Arbiters* (page 288).
- **Non-Voting**: These members do not vote in elections. Non-voting members are only used for larger sets with more than 12 members. See *Non-Voting Members* (page 288).

For more information about each member configuration, see the *Member Configurations* (page 285) section in the *Replica Set Operation and Management* (page 285) document.

29.1.2 Failover

Replica sets feature automated failover. If the *primary* goes offline or becomes unresponsive and a majority of the original set members can still connect to each other, the set will elect a new primary.

For a detailed explanation of failover, see the *Failover and Recovery* (page 298) section in the *Replica Set Operation and Management* (page 285) document.

Elections

When any failover occurs, an election takes place to decide which member should become primary.

Elections provide a mechanism for the members of a *replica set* to autonomously select a new *primary* without administrator intervention. The election allows replica sets to recover from failover situations very quickly and robustly.

Whenever the primary becomes unreachable, the secondary members trigger an election. The first member to receive votes from a majority of the set will become primary. The most important feature of replica set elections is that a majority of the original number of members in the replica set must be present for election to succeed. If you have a three-member replica set, the set can elect a primary when two or three members can connect to each other. If two members in the replica go offline, then the remaining member will remain a secondary.

Note: When the current *primary* steps down and triggers an election, the `mongod` (page 897) instances will close all client connections. This ensures that the clients maintain an accurate view of the *replica set* and helps prevent *rollbacks*.

For more information on elections and failover, see:

- The *Failover and Recovery* (page 298) section in the *Replica Set Operation and Management* (page 285) document.
- The *Election Internals* (page 314) section in the *Replica Set Internals and Behaviors* (page 312) document

Member Priority

In a replica set, every member has a "priority," that helps determine eligibility for *election* (page 280) to *primary*. By default, all members have a priority of `1`, unless you modify the `priority` (page 991) value. All members have a single vote in elections.

Warning: Always configure the `priority` (page 991) value to control which members will become primary. Do not configure `votes` (page 991) except to permit more than 7 secondary members.

For more information on member priorities, see the *Adjusting Priority* (page 290) section in the *Replica Set Operation and Management* (page 285) document.

29.1.3 Consistency

This section provides an overview of the concepts that underpin database consistency and the MongoDB mechanisms to ensure that users have access to consistent data.

In MongoDB, all read operations issued to the primary of a replica set are *consistent* with the last write operation.

If clients configure the *read preference* to permit secondary reads, read operations cannot return from *secondary* members that have not replicated more recent updates or operations. In these situations the query results may reflect a previous state.

This behavior is sometimes characterized as *eventual consistency* because the secondary member's state will *eventually* reflect the primary's state and MongoDB cannot guarantee *strict consistency* for read operations from secondary members.

There is no way to guarantee consistency for reads from *secondary members,* except by configuring the *client* and *driver* to ensure that write operations succeed on all members before completing successfully.

Rollbacks

In some *failover* situations *primaries* will have accepted write operations that have *not* replicated to the *secondaries* after a failover occurs. This case is rare and typically occurs as a result of a network partition with replication lag. When this member (the former primary) rejoins the *replica set* and attempts to continue replication as a secondary the former primary must revert these operations or "roll back" these operations to maintain database consistency across the replica set.

MongoDB writes the rollback data to a *BSON* file in the database's `dbpath` (page 947) directory. Use *bsondump* (page 921) to read the contents of these rollback files and then manually apply the changes to the new primary. There is no way for MongoDB to appropriately and fairly handle rollback situations automatically. Therefore you must intervene manually to apply rollback data. Even after the member completes the rollback and returns to secondary status, administrators will need to apply or decide to ignore the rollback data. MongoDB writes rollback data to a `rollback/` folder within the `dbpath` (page 947) directory to files with filenames in the following form:

```
<database>.<collection>.<timestamp>.bson
```

For example:

```
records.accounts.2011-05-09T18-10-04.0.bson
```

The best strategy for avoiding all rollbacks is to ensure *write propagation* (page 303) to all or some of the members in the set. Using these kinds of policies prevents situations that might create rollbacks.

Warning: A `mongod` (page 897) instance will not rollback more than 300 megabytes of data. If your system needs to rollback more than 300 MB, you will need to manually intervene to recover this data. If this is the case, you will find the following line in your `mongod` (page 897) log:

```
[replica set sync] replSet syncThread: 13410 replSet too much data to roll back
```

In these situations you will need to manually intervene to either save data or to force the member to perform an initial sync from a "current" member of the set by deleting the content of the existing `dbpath` (page 947) directory.

For more information on failover, see:

- The *Failover* (page 280) section in this document.
- The *Failover and Recovery* (page 298) section in the *Replica Set Operation and Management* (page 285) document.

Application Concerns

Client applications are indifferent to the configuration and operation of replica sets. While specific configuration depends to some extent on the client *drivers* (page 435), there is often minimal or no difference between applications using *replica sets* or standalone instances.

There are two major concepts that *are* important to consider when working with replica sets:

1. *Write Concern* (page 124).

   Write concern sends a MongoDB client a response from the server to confirm successful write operations. In replica sets you can configure *replica acknowledged* (page 125) write concern to ensure that secondary members of the set have replicated operations before the write returns.

2. *Read Preference* (page 306)

   By default, read operations issued against a replica set return results from the *primary*. Users may configure *read preference* on a per-connection basis to prefer that read operations return on the *secondary* members.

Read preference and *write concern* have particular *consistency* (page 281) implications.

For a more detailed discussion of application concerns, see *Replica Set Considerations and Behaviors for Applications and Development* (page 303).

29.1.4 Administration and Operations

This section provides a brief overview of concerns relevant to administrators of *replica set* deployments.

For more information on replica set administration, operations, and architecture, see:

- *Replica Set Operation and Management* (page 285)
- *Replica Set Architectures and Deployment Patterns* (page 300)

Oplog

The *oplog* (operations log) is a special *capped collection* that keeps a rolling record of all operations that modify that data stored in your databases. MongoDB applies database operations on the *primary* and then records the operations on the primary's oplog. The *secondary* members then replicate this log and apply the operations to themselves in an asynchronous process. All replica set members contain a copy of the oplog, allowing them to maintain the current state of the database. Operations in the oplog are *idempotent*.

By default, the size of the oplog is as follows:

- For 64-bit Linux, Solaris, FreeBSD, and Windows systems, MongoDB will allocate 5% of the available free disk space to the oplog.

  If this amount is smaller than a gigabyte, then MongoDB will allocate 1 gigabyte of space.

- For 64-bit OS X systems, MongoDB allocates 183 megabytes of space to the oplog.
- For 32-bit systems, MongoDB allocates about 48 megabytes of space to the oplog.

Before oplog creation, you can specify the size of your oplog with the `oplogSize` (page 952) option. After you start a replica set member for the first time, you can only change the size of the oplog by using the *Change the Size of the Oplog* (page 336) tutorial.

In most cases, the default oplog size is sufficient. For example, if an oplog that is 5% of free disk space fills up in 24 hours of operations, then secondaries can stop copying entries from the oplog for up to 24 hours without becoming stale. However, most replica sets have much lower operation volumes, and their oplogs can hold a much larger number of operations.

The following factors affect how MongoDB uses space in the oplog:

- Update operations that affect multiple documents at once.

  The oplog must translate multi-updates into individual operations, in order to maintain *idempotency*. This can use a great deal of oplog space without a corresponding increase in disk utilization.

- If you delete roughly the same amount of data as you insert.

  In this situation the database will not grow significantly in disk utilization, but the size of the operation log can be quite large.

- If a significant portion of your workload entails in-place updates.

  In-place updates create a large number of operations but do not change the quantity data on disk.

If you can predict your replica set's workload to resemble one of the above patterns, then you may want to consider creating an oplog that is larger than the default. Conversely, if the predominance of activity of your MongoDB-based application are reads and you are writing a small amount of data, you may find that you need a much smaller oplog.

To view oplog status, including the size and the time range of operations, issue the `db.printReplicationInfo()` (page 852) method. For more information on oplog status, see *Check the Size of the Oplog* (page 297).

For additional information about oplog behavior, see *Oplog Internals* (page 312) and *Syncing* (page 315).

Replica Set Deployment

Without replication, a standalone MongoDB instance represents a single point of failure and any disruption of the MongoDB system will render the database unusable and potentially unrecoverable. Replication increase the reliability of the database instance, and replica sets are capable of distributing reads to *secondary* members depending on *read preference*. For database work loads dominated by read operations, (i.e. "read heavy") replica sets can greatly increase the capability of the database system.

The minimum requirements for a replica set include two members with data, for a *primary* and a secondary, and an *arbiter* (page 288). In most circumstances, however, you will want to deploy three data members.

For those deployments that rely heavily on distributing reads to secondary instances, add additional members to the set as load increases. As your deployment grows, consider adding or moving replica set members to secondary data centers or to geographically distinct locations for additional redundancy. While many architectures are possible, always ensure that the quorum of members required to elect a primary remains in your main facility.

Depending on your operational requirements, you may consider adding members configured for a specific purpose including, a *delayed member* to help provide protection against human errors and change control, a *hidden member* to provide an isolated member for reporting and monitoring, and/or a *secondary only member* (page 286) for dedicated backups.

The process of establishing a new replica set member can be resource intensive on existing members. As a result, deploy new members to existing replica sets significantly before current demand saturates the existing members.

Note: *Journaling*, provides single-instance write durability. The journaling greatly improves the reliability and durability of a database. Unless MongoDB runs with journaling, when a MongoDB instance terminates ungracefully, the database can end in a corrupt and unrecoverable state.

You should assume that a database, running without journaling, that suffers a crash or unclean shutdown is in corrupt or inconsistent state.

Use journaling, however, do not forego proper replication because of journaling.

64-bit versions of MongoDB after version 2.0 have journaling enabled by default.

Security

In most cases, *replica set* administrators do not have to keep additional considerations in mind beyond the normal security precautions that all MongoDB administrators must take. However, ensure that:

- Your network configuration will allow every member of the replica set to contact every other member of the replica set.
- If you use MongoDB's authentication system to limit access to your infrastructure, ensure that you configure a `keyFile` (page 947) on all members to permit authentication.

For more information, see the *Security Considerations for Replica Sets* (page 294) section in the *Replica Set Operation and Management* (page 285) document.

Architectures

The architecture and design of the *replica set* deployment can have a great impact on the set's capacity and capability. This section provides a general overview of the architectural possibilities for replica set deployments. However, for most production deployments a conventional 3-member replica set with `priority` (page 991) values of `1` are sufficient.

While the additional flexibility discussed is below helpful for managing a variety of operational complexities, it always makes sense to let those complex requirements dictate complex architectures, rather than add unnecessary complexity to your deployment.

Consider the following factors when developing an architecture for your replica set:

- Ensure that the members of the replica set will always be able to elect a *primary*. Run an odd number of members or run an *arbiter* on one of your application servers if you have an even number of members.
- With geographically distributed members, know where the "quorum" of members will be in the case of any network partitions. Attempt to ensure that the set can elect a primary among the members in the primary data center.
- Consider including a *hidden* (page 287) or *delayed member* (page 287) in your replica set to support dedicated functionality, like backups, reporting, and testing.
- Consider keeping one or two members of the set in an off-site data center, but make sure to configure the *priority* (page 280) to prevent it from becoming primary.

- Create custom write concerns with *replica set tags* (page 994) to ensure that applications can control the threshold for a successful write operation. Use these write concerns to ensure that operations propagate to specific data centers or to machines of different functions before returning successfully.

For more information regarding replica set configuration and deployments see *Replica Set Architectures and Deployment Patterns* (page 300).

29.2 Replica Set Operation and Management

Replica sets automate most administrative tasks associated with database replication. Nevertheless, several operations related to deployment and systems management require administrator intervention remain. This document provides an overview of those tasks, in addition to a collection of troubleshooting suggestions for administers of replica sets.

See Also:

- `rs.status()` (page 861) and `db.isMaster()` (page 850)
- *Replica Set Reconfiguration Process* (page 993)
- `rs.conf()` (page 859) and `rs.reconfig()` (page 860)
- *Replica Set Configuration* (page 989)

The following tutorials provide task-oriented instructions for specific administrative tasks related to replica set operation.

- *Deploy a Replica Set* (page 323)
- *Convert a Standalone to a Replica Set* (page 327)
- *Add Members to a Replica Set* (page 328)
- *Deploy a Geographically Distributed Replica Set* (page 330)
- *Change the Size of the Oplog* (page 336)
- *Force a Member to Become Primary* (page 338)
- *Change Hostnames in a Replica Set* (page 340)
- *Convert a Secondary to an Arbiter* (page 344)
- *Reconfigure a Replica Set with Unavailable Members* (page 346)
- *Recover MongoDB Data following Unexpected Shutdown* (page 596)

29.2.1 Member Configurations

All *replica sets* have a single *primary* and one or more *secondaries*. Replica sets allow you to configure secondary members in a variety of ways. This section describes these configurations.

Note: A replica set can have up to 12 members, but only 7 members can have votes. For configuration information regarding non-voting members, see *Non-Voting Members* (page 288).

Warning: The `rs.reconfig()` (page 860) shell method can force the current primary to step down, which causes an *election* (page 280). When the primary steps down, the `mongod` (page 897) closes all client connections. While this typically takes 10-20 seconds, attempt to make these changes during scheduled maintenance periods. To successfully reconfigure a replica set, a majority of the members must be accessible.

See Also:

The *Elections* (page 280) section in the *Replica Set Fundamental Concepts* (page 279) document, and the *Election Internals* (page 314) section in the *Replica Set Internals and Behaviors* (page 312) document.

Secondary-Only Members

The secondary-only configuration prevents a *secondary* member in a *replica set* from ever becoming a *primary* in a *failover*. You can set secondary-only mode for any member of the set except the current primary.

For example, you may want to configure all members of a replica sets located outside of the main data centers as secondary-only to prevent these members from ever becoming primary.

To configure a member as secondary-only, set its `priority` (page 991) value to `0`. Any member with a `priority` (page 991) equal to `0` will never seek *election* (page 280) and cannot become primary in any situation. For more information on priority levels, see *Member Priority* (page 280).

Note: When updating the replica configuration object, address all members of the set using the index value in the array. The array index begins with `0`. Do not confuse this index value with the value of the `_id` (page 990) field in each document in the `members` (page 989) array.

The `_id` (page 990) rarely corresponds to the array index.

As an example of modifying member priorities, assume a four-member replica set. Use the following sequence of operations in the `mongo` (page 908) shell to modify member priorities:

```
cfg = rs.conf()
cfg.members[0].priority = 2
cfg.members[1].priority = 1
cfg.members[2].priority = 0.5
cfg.members[3].priority = 0
rs.reconfig(cfg)
```

This reconfigures the set, with the following priority settings:

- Member `0` to a priority of `2` so that it becomes primary, under most circumstances.
- Member `1` to a priority of `1`, which is the default value. Member `1` becomes primary if no member with a *higher* priority is eligible.
- Member `2` to a priority of `0.5`, which makes it less likely to become primary than other members but doesn't prohibit the possibility.
- Member `3` to a priority of `0`. Member `3` cannot become the *primary* member under any circumstances.

Note: If your replica set has an even number of members, add an *arbiter* (page 288) to ensure that members can quickly obtain a majority of votes in an election for primary.

Note: MongoDB does not permit the current *primary* to have a `priority` (page 991) of `0`. If you want to prevent the current primary from becoming primary, first use `rs.stepDown()` (page 862) to step down the current primary, and then *reconfigure the replica set* (page 993) with `rs.conf()` (page 859) and `rs.reconfig()` (page 860).

See Also:

`priority` (page 991) and *Replica Set Reconfiguration* (page 993).

Hidden Members

Hidden members are part of a replica set but cannot become primary and are invisible to client applications. *However,* hidden members **do** vote in *elections* (page 280).

Hidden members are ideal for instances that will have significantly different usage patterns than the other members and require separation from normal traffic. Typically, hidden members provide reporting, dedicated backups, and dedicated read-only testing and integration support.

Hidden members have `priority` (page 991) set `0` and have `hidden` (page 990) set to `true`.

To configure a *hidden member*, use the following sequence of operations in the `mongo` (page 908) shell:

```
cfg = rs.conf()
cfg.members[0].priority = 0
cfg.members[0].hidden = true
rs.reconfig(cfg)
```

After re-configuring the set, the first member of the set in the `members` (page 989) array will have a priority of `0` so that it cannot become primary. The other members in the set will not advertise the hidden member in the `isMaster` (page 772) or `db.isMaster()` (page 850) output.

Note: You must send the `rs.reconfig()` (page 860) command to a set member that *can* become *primary*. In the above example, if you issue the `rs.reconfig()` (page 860) operation to a member with a `priority` (page 991) of `0` the operation will fail.

Note: Changed in version 2.0. For *sharded clusters* running with replica sets before 2.0 if you reconfigured a member as hidden, you *had* to restart `mongos` (page 905) to prevent queries from reaching the hidden member.

See Also:

Replica Set Read Preference (page 306) and *Replica Set Reconfiguration* (page 993).

Delayed Members

Delayed members copy and apply operations from the primary's *oplog* with a specified delay. If a member has a delay of one hour, then the latest entry in this member's oplog will not be more recent than one hour old, and the state of data for the member will reflect the state of the set an hour earlier.

Example

If the current time is 09:52 and the secondary is a delayed by an hour, no operation will be more recent than 08:52.

Delayed members may help recover from various kinds of human error. Such errors may include inadvertently deleted databases or botched application upgrades. Consider the following factors when determining the amount of slave delay to apply:

- Ensure that the length of the delay is equal to or greater than your maintenance windows.
- The size of the oplog is sufficient to capture *more than* the number of operations that typically occur in that period of time. For more information on oplog size, see the *Oplog* (page 282) topic in the *Replica Set Fundamental Concepts* (page 279) document.

Delayed members must have a *priority* set to `0` to prevent them from becoming primary in their replica sets. Also these members should be *hidden* (page 287) to prevent your application from seeing or querying this member.

To configure a *replica set* member with a one hour delay, use the following sequence of operations in the mongo (page 908) shell:

```
cfg = rs.conf()
cfg.members[0].priority = 0
cfg.members[0].slaveDelay = 3600
rs.reconfig(cfg)
```

After the replica set reconfigures, the first member of the set in the members (page 989) array will have a priority of 0 and cannot become *primary*. The slaveDelay (page 991) value delays both replication and the member's *oplog* by 3600 seconds (1 hour). Setting slaveDelay (page 991) to a non-zero value also sets hidden (page 990) to true for this replica set so that it does not receive application queries in normal operations.

Warning: The length of the secondary slaveDelay (page 991) must fit within the window of the oplog. If the oplog is shorter than the slaveDelay (page 991) window, the delayed member cannot successfully replicate operations.

See Also:

slaveDelay (page 991), *Replica Set Reconfiguration* (page 993), *Oplog* (page 282), *Changing Oplog Size* (page 293) in this document, and the *Change the Size of the Oplog* (page 336) tutorial.

Arbiters

Arbiters are special mongod (page 897) instances that do not hold a copy of the data and thus cannot become primary. Arbiters exist solely to participate in *elections* (page 280).

Note: Because of their minimal system requirements, you may safely deploy an arbiter on a system with another workload, such as an application server or monitoring member.

Warning: Do not run arbiter processes on a system that is an active *primary* or *secondary* of its *replica set*.

Arbiters never receive the contents of any collection but do have the following interactions with the rest of the replica set:

- Credential exchanges that authenticate the arbiter with the replica set. All MongoDB processes within a replica set use keyfiles. These exchanges are encrypted.

  MongoDB only transmits the authentication credentials in a cryptographically secure exchange, and encrypts no other exchange.

- Exchanges of replica set configuration data and of votes. These are not encrypted.

If your MongoDB deployment uses SSL, then all communications between arbiters and the other members of the replica set are secure. See the documentation for *Use MongoDB with SSL Connections* (page 47) for more information. As with all MongoDB components, run arbiters on secure networks.

To add an arbiter, see *Adding an Arbiter* (page 291).

Non-Voting Members

You may choose to change the number of votes that each member has in *elections* (page 280) for *primary*. In general, all members should have only 1 vote to prevent intermittent ties, deadlock, or the wrong members from becoming *primary*. Use *replica set priorities* (page 280) to control which members are more likely to become primary.

To disable a member's ability to vote in elections, use the following command sequence in the `mongo` (page 908) shell.

```
cfg = rs.conf()
cfg.members[3].votes = 0
cfg.members[4].votes = 0
cfg.members[5].votes = 0
rs.reconfig(cfg)
```

This sequence gives `0` votes to the fourth, fifth, and sixth members of the set according to the order of the `members` (page 989) array in the output of `rs.conf()` (page 859). This setting allows the set to elect these members as *primary* but does not allow them to vote in elections. If you have three non-voting members, you can add three additional voting members to your set. Place voting members so that your designated primary or primaries can reach a majority of votes in the event of a network partition.

Note: In general and when possible, all members should have only 1 vote. This prevents intermittent ties, deadlocks, or the wrong members from becoming primary. Use *Replica Set Priorities* (page 280) to control which members are more likely to become primary.

See Also:

`votes` (page 991) and *Replica Set Reconfiguration* (page 993).

Chained Replication

New in version 2.0. Chained replication occurs when a *secondary* member replicates from another secondary member instead of from the *primary*. This might be the case, for example, if a secondary selects its replication target based on ping time and if the closest member is another secondary.

Chained replication can reduce load on the primary. But chained replication can also result in increased replication lag, depending on the topology of the network.

Beginning with version 2.2.4, you can use the `chainingAllowed` (page 992) setting in *Replica Set Configuration* (page 989) to disable chained replication for situations where chained replication is causing lag. For details, see *Chained Replication* (page 289).

29.2.2 Procedures

This section gives overview information on a number of replica set administration procedures. You can find documentation of additional procedures in the *replica set tutorials* (page 323) section.

Adding Members

Before adding a new member to an existing *replica set*, do one of the following to prepare the new member's *data directory*:

- Make sure the new member's data directory *does not* contain data. The new member will copy the data from an existing member.

  If the new member is in a *recovering* state, it must exit and become a *secondary* before MongoDB can copy all data as part of the replication process. This process takes time but does not require administrator intervention.

- Manually copy the data directory from an existing member. The new member becomes a secondary member and will catch up to the current state of the replica set after a short interval. Copying the data over manually shortens the amount of time for the new member to become current.

Ensure that you can copy the data directory to the new member and begin replication within the *window allowed by the oplog* (page 282). If the difference in the amount of time between the most recent operation and the most recent operation to the database exceeds the length of the *oplog* on the existing members, then the new instance will have to perform an initial sync, which completely resynchronizes the data, as described in *Resyncing a Member of a Replica Set* (page 293).

Use `db.printReplicationInfo()` (page 852) to check the current state of replica set members with regards to the oplog.

For the procedure to add a member to a replica set, see *Add Members to a Replica Set* (page 328).

Removing Members

You may remove a member of a replica set at any time; *however*, for best results always *shut down* the `mongod` (page 897) instance before removing it from a replica set. Changed in version 2.2: Before 2.2, you *had* to shut down the `mongod` (page 897) instance before removing it. While 2.2 removes this requirement, it remains good practice. To remove a member, use the `rs.remove()` (page 861) method in the `mongo` (page 908) shell while connected to the current *primary*. Issue the `db.isMaster()` (page 850) command when connected to *any* member of the set to determine the current primary. Use a command in either of the following forms to remove the member:

```
rs.remove("mongo2.example.net:27017")
rs.remove("mongo3.example.net")
```

This operation disconnects the shell briefly and forces a re-connection as the *replica set* renegotiates which member will be primary. The shell displays an error even if this command succeeds.

You can re-add a removed member to a replica set at any time using the *procedure for adding replica set members* (page 289). Additionally, consider using the *replica set reconfiguration procedure* (page 993) to change the `host` (page 990) value to rename a member in a replica set directly.

Replacing a Member

Use this procedure to replace a member of a replica set when the hostname has changed. This procedure preserves all existing configuration for a member, except its hostname/location.

You may need to replace a replica set member if you want to replace an existing system and only need to change the hostname rather than completely replace all configured options related to the previous member.

Use `rs.reconfig()` (page 860) to change the value of the `host` (page 990) field to reflect the new hostname or port number. `rs.reconfig()` (page 860) will not change the value of `_id` (page 990).

```
cfg = rs.conf()
cfg.members[0].host = "mongo2.example.net:27019"
rs.reconfig(cfg)
```

Warning: Any replica set configuration change can trigger the current *primary* to step down, which forces an *election* (page 280). This causes the current shell session, and clients connected to this replica set, to produce an error even when the operation succeeds.

Adjusting Priority

To change the value of the `priority` (page 991) in the replica set configuration, use the following sequence of commands in the `mongo` (page 908) shell:

```
cfg = rs.conf()
cfg.members[0].priority = 0.5
cfg.members[1].priority = 2
cfg.members[2].priority = 2
rs.reconfig(cfg)
```

The first operation uses `rs.conf()` (page 859) to set the local variable `cfg` to the contents of the current replica set configuration, which is a *document*. The next three operations change the `priority` (page 991) value in the `cfg` document for the first three members configured in the `members` (page 989) array. The final operation calls `rs.reconfig()` (page 860) with the argument of `cfg` to initialize the new configuration.

Note: When updating the replica configuration object, address all members of the set using the index value in the array. The array index begins with `0`. Do not confuse this index value with the value of the `_id` (page 990) field in each document in the `members` (page 989) array.

The `_id` (page 990) rarely corresponds to the array index.

If a member has `priority` (page 991) set to `0`, it is ineligible to become *primary* and will not seek election. *Hidden members* (page 287), *delayed members* (page 287), and *arbiters* (page 288) all have `priority` (page 991) set to `0`.

All members have a `priority` (page 991) equal to `1` by default.

The value of `priority` (page 991) can be any floating point (i.e. decimal) number between `0` and `1000`. Priorities are only used to determine the preference in election. The priority value is used only in relation to other members. With the exception of members with a priority of `0`, the absolute value of the `priority` (page 991) value is irrelevant.

Replica sets will preferentially elect and maintain the primary status of the member with the highest `priority` (page 991) setting.

Warning: Replica set reconfiguration can force the current primary to step down, leading to an election for primary in the replica set. Elections cause the current primary to close all open *client* connections.
Perform routine replica set reconfiguration during scheduled maintenance windows.

See Also:

The *Replica Reconfiguration Usage* (page 993) example revolves around changing the priorities of the `members` (page 989) of a replica set.

Adding an Arbiter

For a description of *arbiters* and their purpose in *replica sets*, see *Arbiters* (page 288).

To prevent tied *elections*, do not add an arbiter to a set if the set already has an odd number of voting members.

Because arbiters do not hold a copies of collection data, they have minimal resource requirements and do not require dedicated hardware.

1. Create a data directory for the arbiter. The `mongod` (page 897) uses this directory for configuration information. It *will not* hold database collection data. The following example creates the `http://docs.mongodb.org/v2.2/data/arb` data directory:

   ```
   mkdir /data/arb
   ```

2. Start the arbiter, making sure to specify the replica set name and the data directory. Consider the following example:

```
mongod --port 30000 --dbpath /data/arb --replSet rs
```

3. In a mongo (page 908) shell connected to the *primary*, add the arbiter to the replica set by issuing the rs.addArb() (page 859) method, which uses the following syntax:

   ```
   rs.addArb("<hostname><:port>")
   ```

   For example, if the arbiter runs on m1.example.net:30000, you would issue this command:

   ```
   rs.addArb("m1.example.net:30000")
   ```

Manually Configure a Secondary's Sync Target

To override the default sync target selection logic, you may manually configure a *secondary* member's sync target for pulling *oplog* entries temporarily. The following operations provide access to this functionality:

- replSetSyncFrom (page 791) command, or
- rs.syncFrom() (page 862) helper in the mongo (page 908) shell

Only modify the default sync logic as needed, and always exercise caution. rs.syncFrom() (page 862) will not affect an in-progress initial sync operation. To affect the sync target for the initial sync, run rs.syncFrom() (page 862) operation *before* initial sync.

If you run rs.syncFrom() (page 862) during initial sync, MongoDB produces no error messages, but the sync target will not change until after the initial sync operation.

Note: replSetSyncFrom (page 791) and rs.syncFrom() (page 862) provide a temporary override of default behavior. If:

- the mongod (page 897) instance restarts or
- the connection to the sync target closes;

then, the mongod (page 897) instance will revert to the default sync logic and target.

Manage Chained Replication

New in version 2.2.4. MongoDB enables *chained replication* (page 289) by default. This procedure describes how to disable it and how to re-enable it.

To disable chained replication, set the chainingAllowed (page 992) field in *Replica Set Configuration* (page 989) to false.

You can use the following sequence of commands to set chainingAllowed (page 992) to false:

1. Copy the configuration settings into the cfg object:

   ```
   cfg = rs.config()
   ```

2. Take note of whether the current configuration settings contain the settings sub-document. If they do, skip this step.

   Warning: To avoid data loss, skip this step if the configuration settings contain the settings sub-document.

   If the current configuration settings **do not** contain the settings sub-document, create the sub-document by issuing the following command:

```
cfg.settings = { }
```

3. Issue the following sequence of commands to set `chainingAllowed` (page 992) to `false`:

```
cfg.settings.chainingAllowed = false
rs.reconfig(cfg)
```

To re-enable chained replication, set `chainingAllowed` (page 992) to `true`. You can use the following sequence of commands:

```
cfg = rs.config()
cfg.settings.chainingAllowed = true
rs.reconfig(cfg)
```

Note: If chained replication is disabled, you still can use `replSetSyncFrom` (page 791) to specify that a secondary replicates from another secondary. But that configuration will last only until the secondary recalculates which member to sync from.

Changing Oplog Size

The following is an overview of the procedure for changing the size of the oplog. For a detailed procedure, see *Change the Size of the Oplog* (page 336).

1. Shut down the current *primary* instance in the *replica set* and then restart it on a different port and in "standalone" mode.
2. Create a backup of the old (current) oplog. This is optional.
3. Save the last entry from the old oplog.
4. Drop the old oplog.
5. Create a new oplog of a different size.
6. Insert the previously saved last entry from the old oplog into the new oplog.
7. Restart the server as a member of the replica set on its usual port.
8. Apply this procedure to any other member of the replica set that *could become* primary.

Resyncing a Member of a Replica Set

When a secondary's replication process falls behind so far that *primary* overwrites oplog entries that the secondary has not yet replicated, that secondary cannot catch up and becomes "stale." When that occurs, you must completely resynchronize the member by removing its data and performing an initial sync.

To do so, use one of the following approaches:

- Restart the `mongod` (page 897) with an empty data directory and let MongoDB's normal initial syncing feature restore the data. This is the more simple option, but may take longer to replace the data.

  See *Automatically Resync a Stale Member* (page 294).

- Restart the machine with a copy of a recent data directory from another member in the *replica set*. This procedure can replace the data more quickly but requires more manual steps.

  See *Resync by Copying All Datafiles from Another Member* (page 294).

Automatically Resync a Stale Member

This procedure relies on MongoDB's regular process for initial sync. This will restore the data on the stale member to reflect the current state of the set. For an overview of MongoDB initial sync process, see the *Syncing* (page 315) section.

To resync the stale member:

1. Stop the stale member's `mongod` (page 897) instance. On Linux systems you can use *`mongod --shutdown`* (page 902) Set *`--dbpath`* (page 899) to the member's data directory, as in the following:

   ```
   mongod --dbpath /data/db/ --shutdown
   ```

2. Delete all data and sub-directories from the member's data directory. By removing the data `dbpath` (page 947), MongoDB will perform a complete resync. Consider making a backup first.

3. Restart the `mongod` (page 897) instance on the member. For example:

   ```
   mongod --dbpath /data/db/ --replSet rsProduction
   ```

   At this point, the `mongod` (page 897) will perform an initial sync. The length of the initial sync may process depends on the size of the database and network connection between members of the replica set.

   Initial sync operations can impact the other members of the set and create additional traffic to the primary, and can only occur if another member of the set is accessible and up to date.

Resync by Copying All Datafiles from Another Member

This approach uses a copy of the data files from an existing member of the replica set, or a back of the data files to "seed" the stale member.

The copy or backup of the data files **must** be sufficiently recent to allow the new member to catch up with the *oplog*, otherwise the member would need to perform an initial sync.

Note: In most cases you cannot copy data files from a running `mongod` (page 897) instance to another, because the data files will change during the file copy operation. Consider the *Backup Strategies for MongoDB Systems* (page 67) documentation for several methods that you can use to capture a consistent snapshot of a running `mongod` (page 897) instance.

After you have copied the data files from the "seed" source, start the `mongod` (page 897) instance and allow it to apply all operations from the oplog until it reflects the current state of the replica set.

29.2.3 Security Considerations for Replica Sets

In most cases, the most effective ways to control access and to secure the connection between members of a *replica set* depend on network-level access control. Use your environment's firewall and network routing to ensure that traffic *only* from clients and other replica set members can reach your `mongod` (page 897) instances. If needed, use virtual private networks (VPNs) to ensure secure connections over wide area networks (WANs.)

Additionally, MongoDB provides an authentication mechanism for `mongod` (page 897) and `mongos` (page 905) instances connecting to replica sets. These instances enable authentication but specify a shared key file that serves as a shared password. New in version 1.8: Added support authentication in replica set deployments.Changed in version 1.9.1: Added support authentication in sharded replica set deployments. To enable authentication add the following option to your configuration file:

```
keyFile = /srv/mongodb/keyfile
```

Note: You may chose to set these run-time configuration options using the *--keyFile* (page 899) (or *mongos --keyFile* (page 906)) options on the command line.

Setting `keyFile` (page 947) enables authentication and specifies a key file for the replica set members to use when authenticating to each other. The content of the key file is arbitrary but must be the same on all members of the replica set and on all `mongos` (page 905) instances that connect to the set.

The key file must be less one kilobyte in size and may only contain characters in the base64 set. The key file must not have group or "world" permissions on UNIX systems. Use the following command to use the OpenSSL package to generate "random" content for use in a key file:

```
openssl rand -base64 753
```

Note: Key file permissions are not checked on Windows systems.

29.2.4 Troubleshooting Replica Sets

This section describes common strategies for troubleshooting *replica sets*.

See Also:

Monitoring Database Systems (page 55).

Check Replica Set Status

To display the current state of the replica set and current state of each member, run the `rs.status()` (page 861) method in a `mongo` (page 908) shell connected to the replica set's *primary*. For descriptions of the information displayed by `rs.status()` (page 861), see *Replica Set Status Reference* (page 987).

Note: The `rs.status()` (page 861) method is a wrapper that runs the `replSetGetStatus` (page 788) database command.

Check the Replication Lag

Replication lag is a delay between an operation on the *primary* and the application of that operation from the *oplog* to the *secondary*. Replication lag can be a significant issue and can seriously affect MongoDB *replica set* deployments. Excessive replication lag makes "lagged" members ineligible to quickly become primary and increases the possibility that distributed read operations will be inconsistent.

To check the current length of replication lag:

- In a `mongo` (page 908) shell connected to the primary, call the `db.printSlaveReplicationInfo()` (page 852) method.

  The returned document displays the `syncedTo` value for each member, which shows you when each member last read from the oplog, as shown in the following example:

```
source:   m1.example.net:30001
    syncedTo: Tue Oct 02 2012 11:33:40 GMT-0400 (EDT)
        = 7475 secs ago (2.08hrs)
source:   m2.example.net:30002
    syncedTo: Tue Oct 02 2012 11:33:40 GMT-0400 (EDT)
        = 7475 secs ago (2.08hrs)
```

Note: The `rs.status()` (page 861) method is a wrapper around the `replSetGetStatus` (page 788) database command.

- Monitor the rate of replication by watching the oplog time in the "replica" graph in the MongoDB Monitoring Service. For more information see the documentation for MMS.

Possible causes of replication lag include:

- **Network Latency**

  Check the network routes between the members of your set to ensure that there is no packet loss or network routing issue.

  Use tools including `ping` to test latency between set members and `traceroute` to expose the routing of packets network endpoints.

- **Disk Throughput**

  If the file system and disk device on the secondary is unable to flush data to disk as quickly as the primary, then the secondary will have difficulty keeping state. Disk-related issues are incredibly prevalent on multi-tenant systems, including vitalized instances, and can be transient if the system accesses disk devices over an IP network (as is the case with Amazon's EBS system.)

  Use system-level tools to assess disk status, including `iostat` or `vmstat`.

- **Concurrency**

  In some cases, long-running operations on the primary can block replication on secondaries. For best results, configure *write concern* (page 124) to require confirmation of replication to secondaries, as described in *Write Concern* (page 303). This prevents write operations from returning if replication cannot keep up with the write load.

  Use the *database profiler* to see if there are slow queries or long-running operations that correspond to the incidences of lag.

- **Appropriate Write Concern**

  If you are performing a large data ingestion or bulk load operation that requires a large number of writes to the primary, particularly with *unacknowledged write concern* (page 124), the secondaries will not be able to read the oplog fast enough to keep up with changes.

  To prevent this, require *write acknowledgment or journaled write concern* (page 124) after every 100, 1,000, or an another interval to provide an opportunity for secondaries to catch up with the primary.

  For more information see:

  - *Write Concern* (page 303)
  - *Oplog* (page 282)

Test Connections Between all Members

All members of a *replica set* must be able to connect to every other member of the set to support replication. Always verify connections in both "directions." Networking topologies and firewall configurations prevent normal and required connectivity, which can block replication.

Consider the following example of a bidirectional test of networking:

Example

Given a replica set with three members running on three separate hosts:

- `m1.example.net`
- `m2.example.net`
- `m3.example.net`

1. Test the connection from `m1.example.net` to the other hosts with the following operation set `m1.example.net`:

   ```
   mongo --host m2.example.net --port 27017

   mongo --host m3.example.net --port 27017
   ```

2. Test the connection from `m2.example.net` to the other two hosts with the following operation set from `m2.example.net`, as in:

   ```
   mongo --host m1.example.net --port 27017

   mongo --host m3.example.net --port 27017
   ```

   You have now tested the connection between `m2.example.net` and `m1.example.net` in both directions.

3. Test the connection from `m3.example.net` to the other two hosts with the following operation set from the `m3.example.net` host, as in:

   ```
   mongo --host m1.example.net --port 27017

   mongo --host m2.example.net --port 27017
   ```

If any connection, in any direction fails, check your networking and firewall configuration and reconfigure your environment to allow these connections.

Check the Size of the Oplog

A larger *oplog* can give a replica set a greater tolerance for lag, and make the set more resilient.

To check the size of the oplog for a given *replica set* member, connect to the member in a `mongo` (page 908) shell and run the `db.printReplicationInfo()` (page 852) method.

The output displays the size of the oplog and the date ranges of the operations contained in the oplog. In the following example, the oplog is about 10MB and is able to fit about 26 hours (94400 seconds) of operations:

```
configured oplog size:   10.10546875MB
log length start to end: 94400 (26.22hrs)
oplog first event time:  Mon Mar 19 2012 13:50:38 GMT-0400 (EDT)
oplog last event time:   Wed Oct 03 2012 14:59:10 GMT-0400 (EDT)
now:                     Wed Oct 03 2012 15:00:21 GMT-0400 (EDT)
```

The oplog should be long enough to hold all transactions for the longest downtime you expect on a secondary. At a minimum, an oplog should be able to hold minimum 24 hours of operations; however, many users prefer to have 72 hours or even a week's work of operations.

For more information on how oplog size affects operations, see:

- The *Oplog* (page 282) topic in the *Replica Set Fundamental Concepts* (page 279) document.
- The *Delayed Members* (page 287) topic in this document.
- The *Check the Replication Lag* (page 295) topic in this document.

Note: You normally want the oplog to be the same size on all members. If you resize the oplog, resize it on all members.

To change oplog size, see *Changing Oplog Size* (page 293) in this document or see the *Change the Size of the Oplog* (page 336) tutorial.

Failover and Recovery

Replica sets feature automated failover. If the *primary* goes offline or becomes unresponsive and a majority of the original set members can still connect to each other, the set will elect a new primary.

While *failover* is automatic, *replica set* administrators should still understand exactly how this process works. This section below describe failover in detail.

In most cases, failover occurs without administrator intervention seconds after the *primary* either steps down, becomes inaccessible, or becomes otherwise ineligible to act as primary. If your MongoDB deployment does not failover according to expectations, consider the following operational errors:

- No remaining member is able to form a majority. This can happen as a result of network partitions that render some members inaccessible. Design your deployment to ensure that a majority of set members can elect a primary in the same facility as core application systems.
- No member is eligible to become primary. Members must have a `priority` setting greater than `0`, have a state that is less than ten seconds behind the last operation to the *replica set*, and generally be *more* up to date than the voting members.

In many senses, *rollbacks* (page 281) represent a graceful recovery from an impossible failover and recovery situation.

Rollbacks occur when a primary accepts writes that other members of the set do not successfully replicate before the primary steps down. When the former primary begins replicating again it performs a "rollback." Rollbacks remove those operations from the instance that were never replicated to the set so that the data set is in a consistent state. The `mongod` (page 897) program writes rolled back data to a *BSON* file that you can view using `bsondump` (page 921), applied manually using `mongorestore` (page 918).

You can prevent rollbacks using a *replica acknowledged* (page 125) write concern. These write operations require not only the *primary* to acknowledge the write operation, sometimes even the majority of the set to confirm the write operation before returning.

enabling *write concern*.

See Also:

The *Elections* (page 280) section in the *Replica Set Fundamental Concepts* (page 279) document, and the *Election Internals* (page 314) section in the *Replica Set Internals and Behaviors* (page 312) document.

Oplog Entry Timestamp Error

Consider the following error in `mongod` (page 897) output and logs:

```
replSet error fatal couldn't query the local local.oplog.rs collection.  Terminating mongod after 30
<timestamp> [rsStart] bad replSet oplog entry?
```

Often, an incorrectly typed value in the `ts` field in the last *oplog* entry causes this error. The correct data type is Timestamp.

Check the type of the `ts` value using the following two queries against the oplog collection:

```
db = db.getSiblingDB("local")
db.oplog.rs.find().sort({$natural:-1}).limit(1)
db.oplog.rs.find({ts:{$type:17}}).sort({$natural:-1}).limit(1)
```

The first query returns the last document in the oplog, while the second returns the last document in the oplog where the `ts` value is a Timestamp. The `$type` (page 718) operator allows you to select *BSON type* 17, is the Timestamp data type.

If the queries don't return the same document, then the last document in the oplog has the wrong data type in the `ts` field.

Example

If the first query returns this as the last oplog entry:

```
{ "ts" : {t: 1347982456000, i: 1},
  "h" : NumberLong("8191276672478122996"),
  "op" : "n",
  "ns" : "",
  "o" : { "msg" : "Reconfig set", "version" : 4 } }
```

And the second query returns this as the last entry where `ts` has the `Timestamp` type:

```
{ "ts" : Timestamp(1347982454000, 1),
  "h" : NumberLong("6188469075153256465"),
  "op" : "n",
  "ns" : "",
  "o" : { "msg" : "Reconfig set", "version" : 3 } }
```

Then the value for the `ts` field in the last oplog entry is of the wrong data type.

To set the proper type for this value and resolve this issue, use an update operation that resembles the following:

```
db.oplog.rs.update( { ts: { t:1347982456000, i:1 } },
                    { $set: { ts: new Timestamp(1347982456000, 1)}})
```

Modify the timestamp values as needed based on your oplog entry. This operation may take some period to complete because the update must scan and pull the entire oplog into memory.

Duplicate Key Error on `local.slaves`

The *duplicate key on local.slaves* error, occurs when a *secondary* or *slave* changes its hostname and the *primary* or *master* tries to update its `local.slaves` collection with the new name. The update fails because it contains the same `_id` value as the document containing the previous hostname. The error itself will resemble the following.

```
exception 11000 E11000 duplicate key error index: local.slaves.$_id_  dup key: { : ObjectId('<object
```

This is a benign error and does not affect replication operations on the *secondary* or *slave*.

To prevent the error from appearing, drop the `local.slaves` collection from the *primary* or *master*, with the following sequence of operations in the `mongo` (page 908) shell:

```
use local
db.slaves.drop()
```

The next time a *secondary* or *slave* polls the *primary* or *master*, the *primary* or *master* recreates the `local.slaves` collection.

Elections and Network Partitions

Members on either side of a network partition cannot see each other when determining whether a majority is available to hold an election.

That means that if a primary steps down and neither side of the partition has a majority on its own, the set will not elect a new primary and the set will become read only. To avoid this situation, attempt to place a majority of instances in one data center with a minority of instances in a secondary facility.

See Also:

Election Internals (page 314).

29.3 Replica Set Architectures and Deployment Patterns

There is no single ideal *replica set* architecture for every deployment or environment. Indeed the flexibility of replica sets might be their greatest strength. This document describes the most commonly used deployment patterns for replica sets. The descriptions are necessarily not mutually exclusive, and you can combine features of each architecture in your own deployment.

For an overview of operational practices and background information, see the *Architectures* (page 284) topic in the *Replica Set Fundamental Concepts* (page 279) document.

29.3.1 Three Member Sets

The minimum *recommended* architecture for a replica set consists of:

- One *primary* and
- Two *secondary* members, either of which can become the primary at any time.

  This makes *failover* (page 280) possible and ensures there exists two full and independent copies of the data set at all times. If the primary fails, the replica set elects another member as primary and continues replication until the primary recovers.

Note: While not *recommended*, the minimum *supported* configuration for replica sets includes one *primary*, one *secondary*, and one *arbiter* (page 288). The arbiter requires fewer resources and lowers costs but sacrifices operational flexibility and redundancy.

See Also:

Deploy a Replica Set (page 323).

29.3.2 Sets with Four or More Members

To increase redundancy or to provide additional resources for distributing secondary read operations, you can add additional members to a replica set.

When adding additional members, ensure the following architectural conditions are true:

- The set has an odd number of voting members.

  If you have an *even* number of voting members, deploy an *arbiter* (page 288) to create an odd number.

- The set has no more than 7 voting members at a time.

- Members that cannot function as primaries in a *failover* have their `priority` (page 991) values set to `0`.

  If a member cannot function as a primary because of resource or network latency constraints a `priority` (page 991) value of `0` prevents it from being a primary. Any member with a `priority` value greater than `0` is available to be a primary.

- A majority of the set's members operate in the main data center.

See Also:

Add Members to a Replica Set (page 328).

29.3.3 Geographically Distributed Sets

A geographically distributed replica set provides data recovery should one data center fail. These sets include at least one member in a secondary data center. The member has its `priority` (page 991) *set* (page 993) to `0` to prevent the member from ever becoming primary.

In many circumstances, these deployments consist of the following:

- One *primary* in the first (i.e., primary) data center.

- One *secondary* member in the primary data center. This member can become the primary member at any time.

- One secondary member in a secondary data center. This member is ineligible to become primary. Set its `local.system.replset.members[n].priority` (page 991) to `0`.

If the primary is unavailable, the replica set will elect a new primary from the primary data center.

If the *connection* between the primary and secondary data centers fails, the member in the secondary center cannot independently become the primary.

If the primary data center fails, you can manually recover the data set from the secondary data center. With appropriate *write concern* (page 124) there will be no data loss and downtime can be minimal.

When you add a secondary data center, make sure to keep an odd number of members overall to prevent ties during elections for primary by deploying an *arbiter* (page 288) in your primary data center. For example, if you have three members in the primary data center and add a member in a secondary center, you create an even number. To create an odd number and prevent ties, deploy an *arbiter* (page 288) in your primary data center.

See Also:

Deploy a Geographically Distributed Replica Set (page 330)

29.3.4 Non-Production Members

In some cases it may be useful to maintain a member that has an always up-to-date copy of the entire data set but that cannot become primary. You might create such a member to provide backups, to support reporting operations, or to act as a cold standby. Such members fall into one or more of the following categories:

- **Low-Priority**: These members have `local.system.replset.members[n].priority` (page 991) settings such that they are either unable to become *primary* or *very* unlikely to become primary. In all other respects these low-priority members are identical to other replica set member. (See: *Secondary-Only Members* (page 286).)
- **Hidden**: These members cannot become primary *and* the set excludes them from the output of `db.isMaster()` (page 850) and from the output of the database command `isMaster` (page 772). Excluding hidden members from such outputs prevents clients and drivers from using hidden members for secondary reads. (See: *Hidden Members* (page 287).)
- **Voting**: This changes the number of votes that a member of the replica set has in elections. In general, use priority to control the outcome of elections, as weighting votes introduces operational complexities and risks. Only modify the number of votes when you need to have more than 7 members in a replica set. (See: *Non-Voting Members* (page 288).)

Note: All members of a replica set vote in elections *except* for *non-voting* (page 288) members. Priority, hidden, or delayed status does not affect a member's ability to vote in an election.

Backups

For some deployments, keeping a replica set member for dedicated backup purposes is operationally advantageous. Ensure this member is close, from a networking perspective, to the primary or likely primary. Ensure that the *replication lag* is minimal or non-existent. To create a dedicated *hidden member* (page 287) for the purpose of creating backups.

If this member runs with journaling enabled, you can safely use standard *block level backup methods* (page 612) to create a backup of this member. Otherwise, if your underlying system does not support snapshots, you can connect `mongodump` (page 915) to create a backup directly from the secondary member. In these cases, use the `--oplog` (page 916) option to ensure a consistent point-in-time dump of the database state.

See Also:

Backup Strategies for MongoDB Systems (page 67).

Delayed Replication

Delayed members are special `mongod` (page 897) instances in a *replica set* that apply operations from the *oplog* on a delay to provide a running "historical" snapshot of the data set, or a rolling backup. Typically these members provide protection against human error, such as unintentionally deleted databases and collections or failed application upgrades or migrations.

Otherwise, delayed member function identically to *secondary* members, with the following operational differences: they are not eligible for election to primary and do not receive secondary queries. Delayed members *do* vote in *elections* for primary.

See *Replica Set Delayed Nodes* (page 287) for more information about configuring delayed replica set members.

Reporting

Typically *hidden members* provide a substrate for reporting purposes, because the replica set segregates these instances from the cluster. Since no secondary reads reach hidden members, they receive no traffic beyond what replication requires. While hidden members are not electable as primary, they are still able to *vote* in elections for primary. If your operational parameters requires this kind of reporting functionality, see *Hidden Replica Set Nodes* (page 287) and `local.system.replset.members[n].hidden` (page 990) for more information regarding this functionality.

Cold Standbys

For some sets, it may not be possible to initialize a new member in a reasonable amount of time. In these situations, it may be useful to maintain a secondary member with an up-to-date copy for the purpose of replacing another member in the replica set. In most cases, these members can be ordinary members of the replica set, but in large sets, with varied hardware availability, or given some patterns of *geographical distribution* (page 301), you may want to use a member with a different *priority*, *hidden*, or voting status.

Cold standbys may be valuable when your *primary* and "hot standby" *secondaries* members have a different hardware specification or connect via a different network than the main set. In these cases, deploy members with *priority* equal to `0` to ensure that they will never become primary. These members will vote in elections for primary but will never be eligible for election to primary. Consider likely failover scenarios, such as inter-site network partitions, and ensure there will be members eligible for election as primary *and* a quorum of voting members in the main facility.

Note: If your set already has `7` members, set the `local.system.replset.members[n].votes` (page 991) value to `0` for these members, so that they won't vote in elections.

See Also:

Secondary Only (page 286), and *Hidden Nodes* (page 287).

29.3.5 Arbiters

Deploy an *arbiter* to ensure that a replica set will have a sufficient number of members to elect a *primary*. While having replica sets with 2 members is not recommended for production environments, if you have just two members, deploy an arbiter. Also, for *any replica set with an even number of members*, deploy an arbiter.

To deploy an arbiter, see the *Arbiters* (page 288) topic in the *Replica Set Operation and Management* (page 285) document.

29.4 Replica Set Considerations and Behaviors for Applications and Development

From the perspective of a client application, whether a MongoDB instance is running as a single server (i.e. "standalone") or a *replica set* is transparent. However, replica sets offer some configuration options for write and read operations. [2] This document describes those options and their implications.

29.4.1 Write Concern

MongoDB's built-in *write concern* confirms the success of write operations to a *replica set's primary*. Write concern uses the `getLastError` (page 766) command after write operations to return an object with error information or confirmation that there are no errors.

After the *driver write concern change* (page 1061) all officially supported MongoDB drivers enable write concern by default.

[2] *Sharded clusters* where the shards are also replica sets provide the same configuration options with regards to write and read operations.

Verify Write Operations

The default write concern confirms write operations only on the primary. You can configure write concern to confirm write operations to additional replica set members as well by issuing the `getLastError` (page 766) command with the `w` option.

The `w` option confirms that write operations have replicated to the specified number of replica set members, including the primary. You can either specify a number or specify `majority`, which ensures the write propagates to a majority of set members. The following example ensures the operation has replicated to two members (the primary and one other member):

```
db.runCommand( { getLastError: 1, w: 2 } )
```

The following example ensures the write operation has replicated to a majority of the configured members of the set.

```
db.runCommand( { getLastError: 1, w: "majority" } )
```

If you specify a `w` value greater than the number of members that hold a copy of the data (i.e., greater than the number of non-*arbiter* members), the operation blocks until those members become available. This can cause the operation to block forever. To specify a timeout threshold for the `getLastError` (page 766) operation, use the `wtimeout` argument. The following example sets the timeout to 5000 milliseconds:

```
db.runCommand( { getLastError: 1, w: 2, wtimeout:5000 } )
```

Modify Default Write Concern

You can configure your own "default" `getLastError` (page 766) behavior for a replica set. Use the `getLastErrorDefaults` (page 992) setting in the *replica set configuration* (page 989). The following sequence of commands creates a configuration that waits for the write operation to complete on a majority of the set members before returning:

```
cfg = rs.conf()
cfg.settings = {}
cfg.settings.getLastErrorDefaults = {w: "majority"}
rs.reconfig(cfg)
```

The `getLastErrorDefaults` (page 992) setting affects only those `getLastError` (page 766) commands that have *no* other arguments.

Note: Use of insufficient write concern can lead to *rollbacks* (page 281) in the case of *replica set failover* (page 280). Always ensure that your operations have specified the required write concern for your application.

See Also:

Write Concern (page 124) and *Write Concern Options* (page 958)

Custom Write Concerns

You can use replica set tags to create custom write concerns using the `getLastErrorDefaults` (page 992) and `getLastErrorModes` (page 992) replica set settings.

Note: Custom write concern modes specify the field name and a number of *distinct* values for that field. By contrast, read preferences use the value of fields in the tag document to direct read operations.

In some cases, you may be able to use the same tags for read preferences and write concerns; however, you may need to create additional tags for write concerns depending on the requirements of your application.

Single Tag Write Concerns

Consider a five member replica set, where each member has one of the following tag sets:

```
{ "use": "reporting" }
{ "use": "backup" }
{ "use": "application" }
{ "use": "application" }
{ "use": "application" }
```

You could create a custom write concern mode that will ensure that applicable write operations will not return until members with two different values of the `use` tag have acknowledged the write operation. Create the mode with the following sequence of operations in the `mongo` (page 908) shell:

```
cfg = rs.conf()
cfg.settings = { getLastErrorModes: { use2: { "use": 2 } } }
rs.reconfig(cfg)
```

To use this mode pass the string `multiUse` to the `w` option of `getLastError` (page 766) as follows:

```
db.runCommand( { getLastError: 1, w: use2 } )
```

Specific Custom Write Concerns

If you have a three member replica with the following tag sets:

```
{ "disk": "ssd" }
{ "disk": "san" }
{ "disk": "spinning" }
```

You cannot specify a custom `getLastErrorModes` (page 992) value to ensure that the write propagates to the `san` before returning. However, you may implement this write concern policy by creating the following additional tags, so that the set resembles the following:

```
{ "disk": "ssd" }
{ "disk": "san", "disk.san": "san" }
{ "disk": "spinning" }
```

Then, create a custom `getLastErrorModes` (page 992) value, as follows:

```
cfg = rs.conf()
cfg.settings = { getLastErrorModes: { san: { "disk.san": 1 } } }
rs.reconfig(cfg)
```

To use this mode pass the string `san` to the `w` option of `getLastError` (page 766) as follows:

```
db.runCommand( { getLastError: 1, w: san } )
```

This operation will not return until a replica set member with the tag `disk.san` returns.

You may set a custom write concern mode as the default write concern mode using `getLastErrorDefaults` (page 992) replica set as in the following setting:

```
cfg = rs.conf()
cfg.settings.getLastErrorDefaults = { ssd:1 }
rs.reconfig(cfg)
```

See Also:

Tag Sets (page 994) for further information about replica set reconfiguration and tag sets.

29.4.2 Read Preference

Read preference describes how MongoDB clients route read operations to members of a *replica set*.

Background

By default, an application directs its read operations to the *primary* member in a *replica set*. Reading from the primary guarantees that read operations reflect the latest version of a document. However, for an application that does not require fully up-to-date data, you can improve read throughput, or reduce latency, by distributing some or all reads to secondary members of the replica set.

The following are use cases where you might use secondary reads:

- Running systems operations that do not affect the front-end application, operations such as backups and reports.
- Providing low-latency queries for geographically distributed deployments. If one secondary is closer to an application server than the primary, you may see better performance for that application if you use secondary reads.
- Providing graceful degradation in *failover* (page 280) situations where a set has *no* primary for 10 seconds or more. In this use case, you should give the application the `primaryPreferred` (page 307) read preference, which prevents the application from performing reads if the set has no primary.

MongoDB *drivers* allow client applications to configure a *read preference* on a per-connection, per-collection, or per-operation basis. For more information about secondary read operations in the `mongo` (page 908) shell, see the `readPref()` (page 811) method. For more information about a driver's read preference configuration, see the appropriate *MongoDB Drivers and Client Libraries* (page 435) API documentation.

Note: Read preferences affect how an application selects which member to use for read operations. As a result read preferences dictate if the application receives stale or current data from MongoDB. Use appropriate *write concern* policies to ensure proper data replication and consistency.

If read operations account for a large percentage of your application's traffic, distributing reads to secondary members can improve read throughput. However, in most cases *sharding* (page 365) provides better support for larger scale operations, as clusters can distribute read and write operations across a group of machines.

Read Preference Modes

New in version 2.2. MongoDB *drivers* (page 435) support five read preference modes:

- `primary` (page 307)
- `primaryPreferred` (page 307)
- `secondary` (page 307)
- `secondaryPreferred` (page 307)
- `nearest` (page 308)

You can specify a read preference mode on connection objects, database object, collection object, or per-operation. The syntax for specifying the read preference mode is specific to the driver and to the idioms of the host language.

Read preference modes are also available to clients connecting to a *sharded cluster* through a `mongos` (page 905). The `mongos` (page 905) instance obeys specified read preferences when connecting to the *replica set* that provides each *shard* in the cluster.

In the `mongo` (page 908) shell, the `readPref()` (page 811) cursor method provides access to read preferences.

Warning: All read preference modes except `primary` (page 307) may return stale data as *secondaries* replicate operations from the primary with some delay.
Ensure that your application can tolerate stale data if you choose to use a non-`primary` (page 307) mode.

For more information, see *read preference background* (page 306) and *read preference behavior* (page 309). See also the documentation for your driver.

`primary`

All read operations use only the current replica set *primary*. This is the default. If the primary is unavailable, read operations produce an error or throw an exception.

The `primary` (page 307) read preference mode is not compatible with read preference modes that use *tag sets* (page 308). If you specify a tag set with `primary` (page 307), the driver will produce an error.

`primaryPreferred`

In most situations, operations read from the *primary* member of the set. However, if the primary is unavailable, as is the case during *failover* situations, operations read from secondary members.

When the read preference includes a *tag set* (page 308), the client reads first from the primary, if available, and then from *secondaries* that match the specified tags. If no secondaries have matching tags, the read operation produces an error.

Since the application may receive data from a secondary, read operations using the `primaryPreferred` (page 307) mode may return stale data in some situations.

Warning: Changed in version 2.2: `mongos` (page 905) added full support for read preferences. When connecting to a `mongos` (page 905) instance older than 2.2, using a client that supports read preference modes, `primaryPreferred` (page 307) will send queries to secondaries.

`secondary`

Operations read *only* from the *secondary* members of the set. If no secondaries are available, then this read operation produces an error or exception.

Most sets have at least one secondary, but there are situations where there may be no available secondary. For example, a set with a primary, a secondary, and an *arbiter* may not have any secondaries if a member is in recovering state or unavailable.

When the read preference includes a *tag set* (page 308), the client attempts to find secondary members that match the specified tag set and directs reads to a random secondary from among the *nearest group* (page 310). If no secondaries have matching tags, the read operation produces an error. [3]

Read operations using the `secondary` (page 307) mode may return stale data.

`secondaryPreferred`

In most situations, operations read from *secondary* members, but in situations where the set consists of a single *primary* (and no other members,) the read operation will use the set's primary.

[3] If your set has more than one secondary, and you use the `secondary` (page 307) read preference mode, consider the following effect. If you have a *three member replica set* (page 300) with a primary and two secondaries, and if one secondary becomes unavailable, all `secondary` (page 307) queries must target the remaining secondary. This will double the load on this secondary. Plan and provide capacity to support this as needed.

When the read preference includes a *tag set* (page 308), the client attempts to find a secondary member that matches the specified tag set and directs reads to a random secondary from among the *nearest group* (page 310). If no secondaries have matching tags, the read operation produces an error.

Read operations using the `secondaryPreferred` (page 307) mode may return stale data.

`nearest`

The driver reads from the *nearest* member of the *set* according to the *member selection* (page 310) process. Reads in the `nearest` (page 308) mode do not consider the member's *type*. Reads in `nearest` (page 308) mode may read from both primaries and secondaries.

Set this mode to minimize the effect of network latency on read operations without preference for current or stale data.

If you specify a *tag set* (page 308), the client attempts to find a replica set member that matches the specified tag set and directs reads to an arbitrary member from among the *nearest group* (page 310).

Read operations using the `nearest` (page 308) mode may return stale data.

Note: All operations read from a member of the nearest group of the replica set that matches the specified read preference mode. The `nearest` (page 308) mode prefers low latency reads over a member's *primary* or *secondary* status.

For `nearest` (page 308), the client assembles a list of acceptable hosts based on tag set and then narrows that list to the host with the shortest ping time and all other members of the set that are within the "local threshold," or acceptable latency. See *Member Selection* (page 310) for more information.

Tag Sets

Tag sets allow you to specify custom *read preferences* (page 306) and *write concerns* (page 124) so that your application can target operations to specific members, based on custom parameters.

Note: Consider the following properties of read preferences:

- Custom read preferences and write concerns evaluate tags sets in different ways.
- Read preferences consider the value of a tag when selecting a member to read from.
- Write concerns ignore the value of a tag to when selecting a member *except* to consider whether or not the value is unique.

A tag set for a read operation may resemble the following document:

```
{ "disk": "ssd", "use": "reporting" }
```

To fulfill the request, a member would need to have both of these tags. Therefore the following tag sets, would satisfy this requirement:

```
{ "disk": "ssd", "use": "reporting" }
{ "disk": "ssd", "use": "reporting", "rack": 1 }
{ "disk": "ssd", "use": "reporting", "rack": 4 }
{ "disk": "ssd", "use": "reporting", "mem": "64"}
```

However, the following tag sets would *not* be able to fulfill this query:

```
{ "disk": "ssd" }
{ "use": "reporting" }
{ "disk": "ssd", "use": "production" }
```

```
{ "disk": "ssd", "use": "production", "rack": 3 }
{ "disk": "spinning", "use": "reporting", "mem": "32" }
```

Therefore, tag sets make it possible to ensure that read operations target specific members in a particular data center or `mongod` (page 897) instances designated for a particular class of operations, such as reporting or analytics. For information on configuring tag sets, see *Tag Sets* (page 994) in the *Replica Set Configuration* (page 989) document. You can specify tag sets with the following read preference modes:

- `primaryPreferred` (page 307)
- `secondary` (page 307)
- `secondaryPreferred` (page 307)
- `nearest` (page 308)

You cannot specify tag sets with the `primary` (page 307) read preference mode.

Tags are not compatible with `primary` (page 307) and only apply when *selecting* (page 310) a *secondary* member of a set for a read operation. However, the `nearest` (page 308) read mode, when combined with a tag set will select the nearest member that matches the specified tag set, which may be a primary or secondary.

All interfaces use the same *member selection logic* (page 310) to choose the member to which to direct read operations, basing the choice on read preference mode and tag sets.

For more information on how read preference *modes* (page 306) interact with tag sets, see the documentation for each read preference mode.

Behavior

Changed in version 2.2.

Auto-Retry

Connection between MongoDB drivers and `mongod` (page 897) instances in a *replica set* must balance two concerns:

1. The client should attempt to prefer current results, and any connection should read from the same member of the replica set as much as possible.
2. The client should minimize the amount of time that the database is inaccessible as the result of a connection issue, networking problem, or *failover* in a replica set.

As a result, MongoDB drivers and `mongos` (page 905):

- Reuse a connection to specific `mongod` (page 897) for as long as possible after establishing a connection to that instance. This connection is *pinned* to this `mongod` (page 897).
- Attempt to reconnect to a new member, obeying existing *read preference modes* (page 306), if the connection to `mongod` (page 897) is lost.

  Reconnections are transparent to the application itself. If the connection permits reads from *secondary* members, after reconnecting, the application can receive two sequential reads returning from different secondaries. Depending on the state of the individual secondary member's replication, the documents can reflect the state of your database at different moments.
- Return an error *only* after attempting to connect to three members of the set that match the *read preference mode* (page 306) and *tag set* (page 308). If there are fewer than three members of the set, the client will error after connecting to all existing members of the set.

After this error, the driver selects a new member using the specified read preference mode. In the absence of a specified read preference, the driver uses `primary` (page 307).

- After detecting a failover situation, [4] the driver attempts to refresh the state of the replica set as quickly as possible.

Request Association

Reads from *secondary* may reflect the state of the data set at different points in time because *secondary* members of a *replica set* may lag behind the current state of the primary by different amounts. To prevent subsequent reads from jumping around in time, the driver can associate application threads to a specific member of the set after the first read. The thread will continue to read from the same member until:

- The application performs a read with a different read preference.
- The thread terminates.
- The client receives a socket exception, as is the case when there's a network error or when the `mongod` (page 897) closes connections during a *failover*. This triggers a *retry* (page 309), which may be transparent to the application.

If an application thread issues a query with the `primaryPreferred` (page 307) mode while the primary is inaccessible, the thread will carry the association with that secondary for the lifetime of the thread. The thread will associate with the primary, if available, only after issuing a query with a different read preference, even if a primary becomes available. By extension, if a thread issues a read with the `secondaryPreferred` (page 307) when all secondaries are down, it will carry an association with the primary. This application thread will continue to read from the primary even if a secondary becomes available later in the thread's lifetime.

Member Selection

Clients, by way of their drivers, and `mongos` (page 905) instances for sharded clusters periodically update their view of the replica set's state: which members are up or down, which member is primary, and the latency to each `mongod` (page 897) instance.

For any operation that targets a member *other* than the *primary*, the driver:

1. Assembles a list of suitable members, taking into account member type (i.e. secondary, primary, or all members.)
2. Excludes members not matching the tag sets, if specified.
3. Determines which suitable member is the closest to the client in absolute terms.
4. Builds a list of members that are within a defined ping distance (in milliseconds) of the "absolute nearest" member. [5]
5. Selects a member from these hosts at random. The member receives the read operation.

Once the application selects a member of the set to use for read operations, the driver continues to use this connection for read preference until the application specifies a new read preference or something interrupts the connection. See *Request Association* (page 310) for more information.

[4] When a *failover* occurs, all members of the set close all client connections that produce a socket error in the driver. This behavior prevents or minimizes *rollback*.

[5] Applications can configure the threshold used in this stage. The default "acceptable latency" is 15 milliseconds, which you can override in the drivers with their own `secondaryAcceptableLatencyMS` option. For `mongos` (page 905) you can use the `--localThreshold` (page 907) or `localThreshold` (page 954) runtime options to set this value.

Sharding and mongos

Changed in version 2.2: Before version 2.2, mongos (page 905) did not support the *read preference mode semantics* (page 306). In most *sharded clusters*, a *replica set* provides each shard where read preferences are also applicable. Read operations in a sharded cluster, with regard to read preference, are identical to unsharded replica sets.

Unlike simple replica sets, in sharded clusters, all interactions with the shards pass from the clients to the mongos (page 905) instances that are actually connected to the set members. mongos (page 905) is responsible for the application of the read preferences, which is transparent to applications.

There are no configuration changes required for full support of read preference modes in sharded environments, as long as the mongos (page 905) is at least version 2.2. All mongos (page 905) maintain their own connection pool to the replica set members. As a result:

- A request without a specified preference has primary (page 307), the default, unless, the mongos (page 905) reuses an existing connection that has a different mode set.

  Always explicitly set your read preference mode to prevent confusion.

- All nearest (page 308) and latency calculations reflect the connection between the mongos (page 905) and the mongod (page 897) instances, not the client and the mongod (page 897) instances.

  This produces the desired result, because all results must pass through the mongos (page 905) before returning to the client.

Database Commands

Because some *database commands* read and return data from the database, all of the official drivers support full *read preference mode semantics* (page 306) for the following commands:

- group (page 769)
- mapReduce (page 775) [6]
- aggregate (page 740)
- collStats (page 745)
- dbStats (page 753)
- count (page 750)
- distinct (page 753)
- geoNear (page 765)
- geoSearch (page 765)
- geoWalk (page 766)

mongos (page 905) currently does not route commands using read preferences; clients send all commands to shards' primaries. See SERVER-7423.

Uses for non-Primary Read Preferences

You must exercise care when specifying read preferences: modes other than primary (page 307) can *and will* return stale data. These secondary queries will not include the most recent write operations to the replica set's *primary*. Nevertheless, there are several common use cases for using non-primary (page 307) read preference modes:

[6] Only "inline" mapReduce (page 775) operations that do not write data support read preference, otherwise these operations must run on the *primary* members.

- Reporting and analytics workloads.

  Having these queries target a *secondary* helps distribute load and prevent these operations from affecting the main workload of the primary.

  Also consider using `secondary` (page 307) in conjunction with a direct connection to a *hidden member* (page 287) of the set.

- Providing local reads for geographically distributed applications.

  If you have application servers in multiple data centers, you may consider having a *geographically distributed replica set* (page 301) and using a non primary read preference or the `nearest` (page 308) to avoid network latency.

- Maintaining availability during a failover.

  Use `primaryPreferred` (page 307) if you want your application to do consistent reads from the primary under normal circumstances, but to allow stale reads from secondaries in an emergency. This provides a "read-only mode" for your application during a failover.

Warning: In some situations using `secondaryPreferred` (page 307) to distribute read load to replica sets may carry significant operational risk: if all secondaries are unavailable and your set has enough *arbiters* to prevent the primary from stepping down, then the primary will receive all traffic from clients.
For this reason, use `secondary` (page 307) to distribute read load to replica sets, not `secondaryPreferred` (page 307).

Using read modes other than `primary` (page 307) and `primaryPreferred` (page 307) to provide extra capacity is not in and of itself justification for non-`primary` (page 307) in many cases. Furthermore, *sharding* (page 363) increases read and write capacity by distributing read and write operations across a group of machines.

29.5 Replica Set Internals and Behaviors

This document provides a more in-depth explanation of the internals and operation of *replica set* features. This material is not necessary for normal operation or application development but may be useful for troubleshooting and for further understanding MongoDB's behavior and approach.

For additional information about the internals of replication replica sets see the following resources in the MongoDB Manual:

- *The local Database* (page 1018)
- *Replica Set Commands* (page 351)
- *Replication Info Reference* (page 997)
- *Replica Set Configuration* (page 989)

29.5.1 Oplog Internals

For an explanation of the oplog, see *Oplog* (page 282).

Under various exceptional situations, updates to a *secondary's* oplog might lag behind the desired performance time. See *Replication Lag* (page 295) for details.

All members of a *replica set* send heartbeats (pings) to all other members in the set and can import operations to the local oplog from any other member in the set.

Replica set oplog operations are *idempotent*. The following operations require idempotency:

- initial sync
- post-rollback catch-up
- sharding chunk migrations

29.5.2 Read Preference Internals

MongoDB uses *single-master replication* to ensure that the database remains consistent. However, clients may modify the *read preferences* (page 306) on a per-connection basis in order to distribute read operations to the *secondary* members of a *replica set*. Read-heavy deployments may achieve greater query throughput by distributing reads to secondary members. But keep in mind that replication is asynchronous; therefore, reads from secondaries may not always reflect the latest writes to the *primary*.

See Also:

Consistency (page 281)

Note: Use `db.getReplicationInfo()` (page 850) from a secondary member and the *replication status* (page 997) output to asses the current state of replication and determine if there is any unintended replication delay.

29.5.3 Member Configurations

Replica sets can include members with the following four special configurations that affect membership behavior:

- *Secondary-only* (page 286) members have their `priority` (page 991) values set to `0` and thus are not eligible for election as primaries.
- *Hidden* (page 287) members do not appear in the output of `db.isMaster()` (page 850). This prevents clients from discovering and potentially querying the member in question.
- *Delayed* (page 287) members lag a fixed period of time behind the primary. These members are typically used for disaster recovery scenarios. For example, if an administrator mistakenly truncates a collection, and you discover the mistake within the lag window, then you can manually fail over to the delayed member.
- *Arbiters* (page 288) exist solely to participate in elections. They do not replicate data from the primary.

In almost every case, replica sets simplify the process of administering database replication. However, replica sets still have a unique set of administrative requirements and concerns. Choosing the right *system architecture* (page 300) for your data set is crucial.

See Also:

The *Member Configurations* (page 285) topic in the *Replica Set Operation and Management* (page 285) document.

29.5.4 Security Internals

Administrators of replica sets also have unique *monitoring* (page 61) and *security* (page 294) concerns. The *replica set functions* (page 893) in the `mongo` (page 908) shell, provide the tools necessary for replica set administration. In particular use the `rs.conf()` (page 859) to return a *document* that holds the *replica set configuration* (page 989) and use `rs.reconfig()` (page 860) to modify the configuration of an existing replica set.

29.5.5 Election Internals

Elections are the process *replica set* members use to select which member should become *primary*. A primary is the only member in the replica set that can accept write operations, including `insert()` (page 830), `update()` (page 842), and `remove()` (page 838).

The following events can trigger an election:

- You initialize a replica set for the first time.
- A primary steps down. A primary will step down in response to the `replSetStepDown` (page 790) command or if it sees that one of the current secondaries is eligible for election *and* has a higher priority. A primary also will step down when it cannot contact a majority of the members of the replica set. When the current primary steps down, it closes all open client connections to prevent clients from unknowingly writing data to a non-primary member.
- A *secondary* member loses contact with a primary. A secondary will call for an election if it cannot establish a connection to a primary.
- A *failover* occurs.

In an election, all members have one vote, including *hidden* (page 287) members, *arbiters* (page 288), and even recovering members. Any `mongod` (page 897) can veto an election.

In the default configuration, all members have an equal chance of becoming primary; however, it's possible to set `priority>` values that weight the election. In some architectures, there may be operational reasons for increasing the likelihood of a specific replica set member becoming primary. For instance, a member located in a remote data center should *not* become primary. See: *Member Priority* (page 280) for more information.

Any member of a replica set can veto an election, even if the member is a *non-voting member* (page 288).

A member of the set will veto an election under the following conditions:

- If the member seeking an election is not a member of the voter's set.
- If the member seeking an election is not up-to-date with the most recent operation accessible in the replica set.
- If the member seeking an election has a lower priority than another member in the set that is also eligible for election.
- If a *secondary only member* (page 286) [7] is the most current member at the time of the election, another eligible member of the set will catch up to the state of this secondary member and then attempt to become primary.
- If the current primary member has more recent operations (i.e. a higher "optime") than the member seeking election, from the perspective of the voting member.
- The current primary will veto an election if it has the same or more recent operations (i.e. a "higher or equal optime") than the member seeking election.

The first member to receive votes from a majority of members in a set becomes the next primary until the next election. Be aware of the following conditions and possible situations:

- Replica set members send heartbeats (pings) to each other every 2 seconds. If a heartbeat does not return for more than 10 seconds, the other members mark the delinquent member as inaccessible.
- Replica set members compare priorities only with other members of the set. The absolute value of priorities does not have any impact on the outcome of replica set elections, with the exception of the value `0`, which indicates the member cannot become primary and cannot seek election. For details, see *Adjusting Priority* (page 290).
- A replica set member cannot become primary *unless* it has the highest "optime" of any visible member in the set.

[7] Remember that *hidden* (page 287) and *delayed* (page 287) imply *secondary-only* (page 286) configuration.

- If the member of the set with the highest priority is within 10 seconds of the latest *oplog* entry, then the set will *not* elect a primary until the member with the highest priority catches up to the latest operation.

See Also:

Non-voting members in a replica set (page 288), *Adjusting Priority* (page 290), and `replica configuration`.

29.5.6 Syncing

In order to remain up-to-date with the current state of the *replica set*, set members *sync*, or copy, *oplog* entries from other members. Members sync data at two different points:

- *Initial sync* occurs when MongoDB creates new databases on a new or restored member, populating the member with the replica set's data. When a new or restored member joins or rejoins a set, the member waits to receive heartbeats from other members. By default, the member syncs from the *the closest* member of the set that is either the primary or another secondary with more recent oplog entries. This prevents two secondaries from syncing from each other.
- *Replication* occurs continually after initial sync and keeps the member updated with changes to the replica set's data.

In MongoDB 2.0, secondaries only change sync targets if the connection to the sync target drops [8] or produces an error.

For example:

1. If you have two secondary members in one data center and a primary in a second facility, and if you start all three instances at roughly the same time (i.e. with no existing data sets or oplog), both secondaries will likely sync from the primary, as neither secondary has more recent oplog entries.

   If you restart one of the secondaries, then when it rejoins the set it will likely begin syncing from the other secondary, because of proximity.

2. If you have a primary in one facility and a secondary in an alternate facility, and if you add another secondary to the alternate facility, the new secondary will likely sync from the existing secondary because it is closer than the primary.

In MongoDB 2.2, secondaries also use the following additional sync behaviors:

- Secondaries will sync from *delayed members* (page 287) *only* if no other member is available.
- Secondaries will *not* sync from *hidden members* (page 287).
- Secondaries will *not* start syncing from a member in a *recovering* state.
- For one member to sync from another, both members must have the same value, either `true` or `false`, for the `buildIndexes` (page 990) field.

29.5.7 Multithreaded Replication

MongoDB applies write operations in batches using a multithreaded approach. The replication process divides each batch among a group of threads which apply many operations with greater concurrency.

Even though threads may apply operations out of order, a client reading data from a secondary will never return documents that reflect an in-between state that never existed on the primary. To ensure this consistency, MongoDB blocks all read operations while applying the batch of operations.

[8] Secondaries will stop syncing from a member if the connection used to poll oplog entries is unresponsive for 30 seconds. If a connection times out, the member may select a new member to sync from. Before version 2.2, secondaries would way 10 minutes to select a new member to sync from.

To help improve the performance of operation application, MongoDB fetches all the memory pages that hold data and indexes that the operations in the batch will affect. The prefetch stage minimizes the amount of time MongoDB must hold the write lock to apply operations. See the `replIndexPrefetch` (page 952) setting to modify the index fetching behavior.

29.5.8 Pre-Fetching Indexes to Improve Replication Throughput

By default, secondaries will in most cases pre-fetch *Indexes* (page 239) associated with the affected document to improve replication throughput.

You can limit this feature to pre-fetch only the index on the `_id` field, or you can disable this feature entirely. For more information, see `replIndexPrefetch` (page 952).

The following document describes master-slave replication, which is deprecated. Use replica sets instead of master-slave in all new deployments.

29.6 Master Slave Replication

Deprecated since version 1.6: *Replica sets* (page 279) replace *master-slave* replication. Use replica sets rather than master-slave replication for all new production deployments. Replica sets provide functional super-set of master-slave and are more robust for production use. Master-slave replication preceded replica and makes it possible have a large number of non-master (i.e. slave) and to *only* replicate operations for a single database; however, master-slave replication provides less redundancy, and does not automate failover. See *Deploy Master-Slave Equivalent using Replica Sets* (page 318) for a replica set configuration that is equivalent to master-slave replication.

Warning: This documentation remains to support legacy deployments and for archival purposes, *only*.

29.6.1 Fundamental Operations

Initial Deployment

To configure a *master-slave* deployment, start two `mongod` (page 897) instances: one in `master` (page 953) mode, and the other in `slave` (page 953) mode.

To start a `mongod` (page 897) instance in `master` (page 953) mode, invoke `mongod` (page 897) as follows:

```
mongod --master --dbpath /data/masterdb/
```

With the *`--master`* (page 903) option, the `mongod` (page 897) will create a `local.oplog.$main` (page 1019) collection, which the "operation log" that queues operations that the slaves will apply to replicate operations from the master. The *`--dbpath`* (page 899) is optional.

To start a `mongod` (page 897) instance in `slave` (page 953) mode, invoke `mongod` (page 897) as follows:

```
mongod --slave --source <masterhostname><:<port>> --dbpath /data/slavedb/
```

Specify the hostname and port of the master instance to the *`--source`* (page 903) argument. The *`--dbpath`* (page 899) is optional.

For `slave` (page 953) instances, MongoDB stores data about the source server in the `local.sources` (page 1019) collection.

Configuration Options for Master-Slave Deployments

As an alternative to specifying the *--source* (page 903) run-time option, can add a document to `local.sources` (page 1019) specifying the `master` (page 953) instance, as in the following operation in the `mongo` (page 908) shell:

```
1 use local
2 db.sources.find()
3 db.sources.insert( { host: <masterhostname> <,only: databasename> } );
```

In line 1, you switch context to the `local` database. In line 2, the `find()` (page 820) operation should return no documents, to ensure that there are no documents in the `sources` collection. Finally, line 3 uses `db.collection.insert()` (page 830) to insert the source document into the `local.sources` (page 1019) collection. The model of the `local.sources` (page 1019) document is as follows:

host
: The host field specifies the `master` (page 953)`mongod` (page 897) instance, and holds a resolvable hostname, i.e. IP address, or a name from a `host` file, or preferably a fully qualified domain name.

  You can append `<:port>` to the host name if the `mongod` (page 897) is not running on the default `27017` port.

only
: Optional. Specify a name of a database. When specified, MongoDB will only replicate the indicated database.

Operational Considerations for Replication with Master Slave Deployments

Master instances store operations in an *oplog* which is a *capped collection* (page 440). As a result, if a slave falls too far behind the state of the master, it cannot "catchup" and must re-sync from scratch. Slave may become out of sync with a master if:

- The slave falls far behind the data updates available from that master.
- The slave stops (i.e. shuts down) and restarts later after the master has overwritten the relevant operations from the master.

When slaves, are out of sync, replication stops. Administrators must intervene manually to restart replication. Use the `resync` (page 792) command. Alternatively, the *--autoresync* (page 904) allows a slave to restart replication automatically, after ten second pause, when the slave falls out of sync with the master. With *--autoresync* (page 904) specified, the slave will only attempt to re-sync once in a ten minute period.

To prevent these situations you should specify the a larger oplog when you start the `master` (page 953) instance, by adding the *--oplogSize* (page 903) option when starting `mongod` (page 897). If you do not specify *--oplogSize* (page 903), `mongod` (page 897) will allocate 5% of available disk space on start up to the oplog, with a minimum of 1GB for 64bit machines and 50MB for 32bit machines.

29.6.2 Run time Master-Slave Configuration

MongoDB provides a number of run time configuration options for `mongod` (page 897) instances in *master-slave* deployments. You can specify these options in *configuration files* (page 33) or on the command-line. See documentation of the following:

- For *master* nodes:
  - `master` (page 953)
  - `slave` (page 953)
- For *slave* nodes:

- source (page 953)
- only (page 953)
- slaveDelay (page 953)

Also consider the *Master-Slave Replication Command Line Options* (page 903) for related options.

Diagnostics

On a *master* instance, issue the following operation in the mongo (page 908) shell to return replication status from the perspective of the master:

```
db.printReplicationInfo()
```

On a *slave* instance, use the following operation in the mongo (page 908) shell to return the replication status from the perspective of the slave:

```
db.printSlaveReplicationInfo()
```

Use the serverStatus (page 792) as in the following operation, to return status of the replication:

```
db.serverStatus()
```

See *server status repl fields* (page 973) for documentation of the relevant section of output.

29.6.3 Security

When running with auth (page 947) enabled, in *master-slave* deployments, you must create a user account for the local database on both mongod (page 897) instances. Log in, and authenticate to the admin database on the *slave* instance, and then create the repl user on the local database, with the following operation:

```
use local
db.addUser('repl', <replpassword>)
```

Once created, repeat the operation on the *master* instance.

The slave instance first looks for a user named repl in the local.system.users (page 1020) collection. If present, the slave uses this user account to authenticate to the local database in the master instance. If the repl user does not exist, the slave instance attempts to authenticate using the first user document in the local.system.users (page 1020) collection.

The local database works like the admin database: an account for local has access to the entire server.

See Also:

Security (page 85) for more information about security in mongodb

29.6.4 Ongoing Administration and Operation of Master-Slave Deployments

Deploy Master-Slave Equivalent using Replica Sets

If you want a replication configuration that resembles *master-slave* replication, using *replica sets* replica sets, consider the following replica configuration document. In this deployment hosts <master> and <slave> [9] provide replication that is roughly equivalent to a two-instance master-slave deployment:

[9] In replica set configurations, the host (page 990) field must hold a resolvable hostname.

```
{
  _id : 'setName',
  members : [
    { _id : 0, host : "<master>", priority : 1 },
    { _id : 1, host : "<slave>", priority : 0, votes : 0 }
  ]
}
```

See *Replica Set Configuration* (page 989) for more information about replica set configurations.

Failing over to a Slave (Promotion)

To permanently failover from a unavailable or damaged *master* (A in the following example) to a *slave* (B):

1. Shut down A.
2. Stop mongod (page 897) on B.
3. Back up and move all data files that begin with local on B from the dbpath (page 947).

   Warning: Removing local.* is irrevocable and cannot be undone. Perform this step with extreme caution.

4. Restart mongod (page 897) on B with the *--master* (page 903) option.

Note: This is a one time operation, and is not reversible. A cannot become a slave of B until it completes a full resync.

Inverting Master and Slave

If you have a *master* (A) and a *slave* (B) and you would like to reverse their roles, follow this procedure. The procedure assumes A is healthy, up-to-date and available.

If A is not healthy but the hardware is okay (power outage, server crash, etc.), skip steps 1 and 2 and in step 8 replace all of A's files with B's files in step 8.

If A is not healthy and the hardware is not okay, replace A with a new machine. Also follow the instructions in the previous paragraph.

To invert the master and slave in a deployment:

1. Halt writes on A using the *fsync* command.
2. Make sure B is up to date with the state of A.
3. Shut down B.
4. Back up and move all data files that begin with local on B from the dbpath (page 947) to remove the existing local.sources data.

   Warning: Removing local.* is irrevocable and cannot be undone. Perform this step with extreme caution.

5. Start B with the *--master* (page 903) option.
6. Do a write on B, which primes the *oplog* to provide a new sync start point.
7. Shut down B. B will now have a new set of data files that start with local.

8. Shut down A and replace all files in the dbpath (page 947) of A that start with local with a copy of the files in the dbpath (page 947) of B that begin with local.

   Considering compressing the local files from B while you copy them, as they may be quite large.

9. Start B with the *--master* (page 903) option.
10. Start A with all the usual slave options, but include *fastsync* (page 903).

Creating a Slave from an Existing Master's Disk Image

If you can stop write operations to the *master* for an indefinite period, you can copy the data files from the master to the new *slave* and then start the slave with *--fastsync* (page 903).

Warning: Be careful with *--fastsync* (page 903). If the data on both instances is identical, a discrepancy will exist forever.

fastsync (page 952) is a way to start a slave by starting with an existing master disk image/backup. This option declares that the administrator guarantees the image is correct and completely up-to-date with that of the master. If you have a full and complete copy of data from a master you can use this option to avoid a full synchronization upon starting the slave.

Creating a Slave from an Existing Slave's Disk Image

You can just copy the other *slave's* data file snapshot without any special options. Only take data snapshots when a mongod (page 897) process is down or locked using db.fsyncLock() (page 848).

Resyncing a Slave that is too Stale to Recover

Slaves asynchronously apply write operations from the *master* that the slaves poll from the master's *oplog*. The oplog is finite in length, and if a slave is too far behind, a full resync will be necessary. To resync the slave, connect to a slave using the mongo (page 908) and issue the resync (page 792) command:

```
use admin
db.runCommand( { resync: 1 } )
```

This forces a full resync of all data (which will be very slow on a large database). You can achieve the same effect by stopping mongod (page 897) on the slave, deleting the entire content of the dbpath (page 947) on the slave, and restarting the mongod (page 897).

Slave Chaining

Slaves cannot be "chained." They must all connect to the *master* directly.

If a slave attempts "slave from" another slave you will see the following line in the mongod (page 897) long of the shell:

```
assertion 13051 tailable cursor requested on non capped collection ns:local.oplog.$main
```

Correcting a Slave's Source

To change a *slave's* source, manually modify the slave's `local.sources` (page 1019) collection.

Example

Consider the following: If you accidentally set an incorrect hostname for the slave's `source` (page 953), as in the following example:

```
mongod --slave --source prod.mississippi
```

You can correct this, by restarting the slave without the `--slave` (page 903) and `--source` (page 903) arguments:

```
mongod
```

Connect to this `mongod` (page 897) instance using the `mongo` (page 908) shell and update the `local.sources` (page 1019) collection, with the following operation sequence:

```
use local
```

```
db.sources.update( { host : "prod.mississippi" }, { $set : { host : "prod.mississippi.example.net" } )
```

Restart the slave with the correct command line arguments or with no `--source` (page 903) option. After configuring `local.sources` (page 1019) the first time, the `--source` (page 903) will have no subsequent effect. Therefore, both of the following invocations are correct:

```
mongod --slave --source prod.mississippi.example.net
```

or

```
mongod --slave
```

The slave now polls data from the correct *master*.

CHAPTER 30

Replica Set Tutorials and Procedures

The following tutorials describe a number of common replica set maintenance and operational practices in greater detail.

30.1 Getting Started with Replica Sets

30.1.1 Deploy a Replica Set

This tutorial describes how to create a three-member *replica set* from three existing `mongod` (page 897) instances. The tutorial provides two procedures: one for development and test systems; and a one for production systems.

To instead deploy a replica set from a single standalone MongoDB instance, see *Convert a Standalone to a Replica Set* (page 327). For additional information regarding replica set deployments, see *Replica Set Fundamental Concepts* (page 279) and *Replica Set Architectures and Deployment Patterns* (page 300).

Overview

Three member *replica sets* provide enough redundancy to survive most network partitions and other system failures. Additionally, these sets have sufficient capacity for many distributed read operations. Most deployments require no additional members or configuration.

Requirements

Most replica sets consist of three or more `mongod` (page 897) instances. [1] This tutorial describes a three member set. Production environments should have at least three distinct systems so that each system can run its own instance of `mongod` (page 897). For development systems you can run all three instances of the `mongod` (page 897) process on a local system or within a virtual instance. For production environments, you should maintain as much separation between members as possible. For example, when using virtual machines for production deployments, each member should live on a separate host server, served by redundant power circuits and with redundant network paths.

[1] To ensure smooth *elections* (page 280) always design replica sets with odd numbers of members. Use *Arbiters* (page 288) to ensure the set has odd number of voting members and avoid tied elections.

Procedures

These procedures assume you already have instances of MongoDB installed on the systems you will add as members of your *replica set*. If you have not already installed MongoDB, see the *installation tutorials* (page 3).

Deploy a Development or Test Replica Set

The examples in this procedure create a new replica set named `rs0`.

1. Before creating your replica set, verify that every member can successfully connect to every other member. The network configuration must allow all possible connections between any two members. To test connectivity, see *Test Connections Between all Members* (page 297).
2. Start three instances of `mongod` (page 897) as members of a replica set named `rs0`, as described in this step. For ephemeral tests and the purposes of this guide, you may run the `mongod` (page 897) instances in separate windows of GNU Screen. OS X and most Linux distributions come with screen installed by default [2] systems.
   (a) Create the necessary data directories by issuing a command similar to the following:

   ```
   mkdir -p /srv/mongodb/rs0-0 /srv/mongodb/rs0-1 /srv/mongodb/rs0-2
   ```

   (b) Issue the following commands, each in a distinct screen window:

   ```
   mongod --port 27017 --dbpath /srv/mongodb/rs0-0 --replSet rs0
   mongod --port 27018 --dbpath /srv/mongodb/rs0-1 --replSet rs0
   mongod --port 27019 --dbpath /srv/mongodb/rs0-2 --replSet rs0
   ```

   This starts each instance as a member of a replica set named `rs0`, each running on a distinct port. If you are already using these ports, you can select different ports. See the documentation of the following options for more information: `--port` (page 898), `--dbpath` (page 899), and `--replSet` (page 903).
3. Open a `mongo` (page 908) shell and connect to the first `mongod` (page 897) instance, with the following command:

   ```
   mongo --port 27017
   ```

4. Create a replica set configuration object in the `mongo` (page 908) shell environment to use to initiate the replica set with the following sequence of operations:

   ```
   rsconf = {
              _id: "rs0",
              members: [
                         {
                          _id: 0,
                          host: "<hostname>:27017"
                         }
                        ]
            }
   ```

5. Use `rs.initiate()` (page 860) to initiate a replica set consisting of the current member and using the default configuration:

   ```
   rs.initiate( rsconf )
   ```

6. Display the current *replica configuration* (page 989):

[2] GNU Screen is packaged as `screen` on Debian-based, Fedora/Red Hat-based, and Arch Linux.

```
rs.conf()
```

7. Add the second and third `mongod` (page 897) instances to the replica set using the `rs.add()` (page 858) method. Replace <hostname> with your system's hostname in the following examples:

   ```
   rs.add("<hostname>:27018")
   rs.add("<hostname>:27019")
   ```

   After these commands return you have a fully functional replica set. New replica sets elect a *primary* within a few seconds.

8. Check the status of your replica set at any time with the `rs.status()` (page 861) operation.

See Also:

The documentation of the following shell functions for more information:

- `rs.initiate()` (page 860)
- `rs.conf()` (page 859)
- `rs.reconfig()` (page 860)
- `rs.add()` (page 858)

You may also consider the simple setup script as an example of a basic automatically configured replica set.

Deploy a Production Replica Set

Production replica sets are very similar to the development or testing deployment described above, with the following differences:

- Each member of the replica set resides on its own machine, and the MongoDB processes all bind to port `27017`, which is the standard MongoDB port.
- Each member of the replica set must be accessible by way of resolvable DNS or hostnames in the following scheme:
  - `mongodb0.example.net`
  - `mongodb1.example.net`
  - `mongodb2.example.net`

  Configure DNS names appropriately, *or* set up your systems' `http://docs.mongodb.org/v2.2/etc/hosts` file to reflect this configuration.
- You specify run-time configuration on each system in a *configuration file* (page 944) stored in `http://docs.mongodb.org/v2.2/etc/mongodb.conf` or in a related location. You *do not* specify run-time configuration through command line options.

  For each MongoDB instance, use the following configuration. Set configuration values appropriate to your systems:

  ```
  port = 27017

  bind_ip = 10.8.0.10

  dbpath = /srv/mongodb/

  fork = true

  replSet = rs0
  ```

You do not need to specify an interface with `bind_ip` (page 945). However, if you do not specify an interface, MongoDB listens for connections on all available IPv4 interfaces. Modify `bind_ip` (page 945) to reflect a secure interface on your system that is able to access all other members of the set *and* on which all other members of the replica set can access the current member. The DNS or host names must point and resolve to this IP address. Configure network rules or a virtual private network (i.e. "VPN") to permit this access.

For more documentation on run time options used above and on additional configuration options, see *Configuration File Options* (page 944).

To deploy a production replica set:

1. Before creating your replica set, verify that every member can successfully connect to every other member. The network configuration must allow all possible connections between any two members. To test connectivity, see *Test Connections Between all Members* (page 297).
2. On each system start the `mongod` (page 897) process by issuing a command similar to following:

   ```
   mongod --config /etc/mongodb.conf
   ```

   Note: In production deployments you likely want to use and configure a *control script* to manage this process based on this command. Control scripts are beyond the scope of this document.
3. Open a `mongo` (page 908) shell connected to this host:

   ```
   mongo
   ```

4. Use `rs.initiate()` (page 860) to initiate a replica set consisting of the current member and using the default configuration:

   ```
   rs.initiate()
   ```

5. Display the current *replica configuration* (page 989):

   ```
   rs.conf()
   ```

6. Add two members to the replica set by issuing a sequence of commands similar to the following.

   ```
   rs.add("mongodb1.example.net")
   rs.add("mongodb2.example.net")
   ```

   After these commands return you have a fully functional replica set. New replica sets elect a *primary* within a few seconds.
7. Check the status of your replica set at any time with the `rs.status()` (page 861) operation.

See Also:

The documentation of the following shell functions for more information:

- `rs.initiate()` (page 860)
- `rs.conf()` (page 859)
- `rs.reconfig()` (page 860)
- `rs.add()` (page 858)

30.1.2 Convert a Standalone to a Replica Set

While *standalone* MongoDB instances are useful for testing, development and trivial deployments, for production use, *replica sets* provide required robustness and disaster recovery. This tutorial describes how to convert an existing standalone instance into a three-member replica set. If you're deploying a replica set "fresh," without any existing MongoDB data or instance, see *Deploy a Replica Set* (page 323).

For more information on *replica sets, their use, and administration* (page 277), see:

- *Replica Set Fundamental Concepts* (page 279),
- *Replica Set Architectures and Deployment Patterns* (page 300),
- *Replica Set Operation and Management* (page 285), and
- *Replica Set Considerations and Behaviors for Applications and Development* (page 303).

Note: If you're converting a standalone instance into a replica set that is a *shard* in a *sharded cluster* you must change the shard host information in the *config database*. While connected to a `mongos` (page 905) instance with a `mongo` (page 908) shell, issue a command in the following form:

```
db.getSiblingDB("config").shards.save( {_id: "<name>", host: "<replica-set>/<member,><member,><...>"
```

Replace `<name>` with the name of the shard, replace `<replica-set>` with the name of the replica set, and replace `<member,><member,><>` with the list of the members of the replica set.

After completing this operation you must restart all `mongos` (page 905) instances. When possible you should restart all components of the replica sets (i.e. all `mongos` (page 905) and all shard `mongod` (page 897) instances.)

Procedure

This procedure assumes you have a *standalone* instance of MongoDB installed. If you have not already installed MongoDB, see the *installation tutorials* (page 3).

1. Shut down the your MongoDB instance and then restart using the `--replSet` (page 903) option and the name of the *replica set*, which is `rs0` in the example below.

   Use a command similar to the following:

   ```
   mongod --port 27017 --dbpath /srv/mongodb/db0 --replSet rs0
   ```

   Replace `http://docs.mongodb.org/v2.2/srv/mongodb/db0` with the path of your `dbpath` (page 947).

   This starts the instance as a member of a replica set named `rs0`. For more information on configuration options, see *Configuration File Options* (page 944) and the *mongod* (page 897).

2. Open a `mongo` (page 908) shell and connect to the `mongod` (page 897) instance. In a new system shell session, use the following command to start a `mongo` (page 908) shell:

   ```
   mongo
   ```

3. Use `rs.initiate()` (page 860) to initiate the replica set:

   ```
   rs.initiate()
   ```

   The set is now operational. To return the replica set configuration, call the `rs.conf()` (page 859) method. To check the status of the replica set, use `rs.status()` (page 861).

4. Now add additional replica set members. On two distinct systems, start two new standalone mongod (page 897) instances. Then, in the mongo (page 908) shell instance connected to the first mongod (page 897) instance, issue a command in the following form:

   ```
   rs.add("<hostname><:port>")
   ```

   Replace <hostname> and <port> with the resolvable hostname and port of the mongod (page 897) instance you want to add to the set. Repeat this operation for each mongod (page 897) that you want to add to the set.

   For more information on adding hosts to a replica set, see the *Add Members to a Replica Set* (page 328) document.

30.1.3 Add Members to a Replica Set

Overview

This tutorial explains how to add an additional member to an existing replica set.

Before adding a new member, see the *Adding Members* (page 289) topic in the *Replica Set Operation and Management* (page 285) document.

For background on replication deployment patterns, see the *Replica Set Architectures and Deployment Patterns* (page 300) document.

Requirements

1. An active replica set.
2. A new MongoDB system capable of supporting your dataset, accessible by the active replica set through the network.

If neither of these conditions are satisfied, please use the MongoDB *installation tutorial* (page 3) and the *Deploy a Replica Set* (page 323) tutorial instead.

Procedures

The examples in this procedure use the following configuration:

- The active replica set is rs0.
- The new member to be added is mongodb3.example.net.
- The mongod (page 897) instance default port is 27017.
- The mongodb.conf configuration file exists in the http://docs.mongodb.org/v2.2/etc directory and contains the following replica set information:

```
port = 27017

bind_ip = 10.8.0.10

dbpath = /srv/mongodb/db0

logpath = /var/log/mongodb.log

fork = true

replSet = rs0
```

For more information on configuration options, see *Configuration File Options* (page 944).

Add a Member to an Existing Replica Set

This procedure uses the above *example configuration* (page 328).

1. Deploy a new `mongod` (page 897) instance, specifying the name of the replica set. You can do this one of two ways:

   - Using the `mongodb.conf` file. On the *primary*, issue a command that resembles the following:

     ```
     mongod --config /etc/mongodb.conf
     ```

   - Using command line arguments. On the *primary*, issue command that resembles the following:

     ```
     mongod --dbpath /srv/mongodb/db0 --replSet rs0
     ```

   Replace `http://docs.mongodb.org/v2.2/srv/mongodb/db0` with the path of your `dbpath` (page 947).

   Take note of the host name and port information for the new `mongod` (page 897) instance.

2. Open a `mongo` (page 908) shell connected to the replica set's primary:

   ```
   mongo
   ```

   Note: The primary is the only member that can add or remove members from the replica set. If you do not know which member is the primary, log into any member of the replica set using `mongo` (page 908) and issue the `db.isMaster()` (page 850) command to determine which member is in the `isMaster.primary` (page 773) field. For example, on the system shell:

   ```
   mongo mongodb0.example.net
   ```

   Then in the `mongo` (page 908) shell:

   ```
   db.isMaster()
   ```

   If you are not connected to the primary, disconnect from the current client and reconnect to the primary.

   ---

3. In the `mongo` (page 908) shell, issue the following command to add the new member to the replica set.

   ```
   rs.add("mongodb3.example.net")
   ```

   Note: You can also include the port number, depending on your setup:

   ```
   rs.add("mongodb3.example.net:27017")
   ```

   ---

4. Verify that the member is now part of the replica set by calling the `rs.conf()` (page 859) method, which displays the *replica set configuration* (page 989):

   ```
   rs.conf()
   ```

   You can use the `rs.status()` (page 861) function to provide an overview of *replica set status* (page 987).

Add a Member to an Existing Replica Set (Alternate Procedure)

Alternately, you can add a member to a replica set by specifying an entire configuration document with some or all of the fields in a `members` (page 989) sub-documents. For example:

```
rs.add({_id: 1, host: "mongodb3.example.net:27017", priority: 0, hidden: true})
```

This configures a *hidden member* that is accessible at `mongodb3.example.net:27017`. See `host` (page 990), `priority` (page 991), and `hidden` (page 990) for more information about these settings. When you specify a full configuration object with `rs.add()` (page 858), you must declare the `_id` field, which is not automatically populated in this case.

Production Notes

- In production deployments you likely want to use and configure a *control script* to manage this process based on this command.
- A member can be removed from a set and re-added later. If the removed member's data is still relatively fresh, it can recover and catch up from its old data set. See the `rs.add()` (page 858) and `rs.remove()` (page 861) helpers.
- If you have a backup or snapshot of an existing member, you can move the data files (i.e. `http://docs.mongodb.org/v2.2/data/db` or `dbpath` (page 947)) to a new system and use them to quickly initiate a new member. These files must be:
  - clean: the existing dataset must be from a consistent copy of the database from a member of the same replica set. See the *Backup Strategies for MongoDB Systems* (page 67) document for more information.
  - recent: the copy must more recent than the oldest operation in the *primary* member's *oplog*. The new secondary must be able to become current using operations from the primary's oplog.
- There is a maximum of seven *voting members* (page 314) in any replica set. When adding more members to a replica set that already has seven votes, you must either:
  - add the new member as a *non-voting members* (page 288) or,
  - remove votes from an `existing member` (page 991).

30.1.4 Deploy a Geographically Distributed Replica Set

This tutorial outlines the process for deploying a *replica set* with members in multiple locations. The tutorial addresses three-member sets, four-member sets, and sets with more than four members.

For appropriate background, see *Replica Set Fundamental Concepts* (page 279) and *Replica Set Architectures and Deployment Patterns* (page 300). For related tutorials, see *Deploy a Replica Set* (page 323) and *Add Members to a Replica Set* (page 328).

Overview

While *replica sets* provide basic protection against single-instance failure, when all of the members of a replica set reside in a single facility, the replica set is still susceptible to some classes of errors in that facility including power outages, networking distortions, and natural disasters. To protect against these classes of failures, deploy a replica set with one or more members in a geographically distinct facility or data center.

Requirements

For a three-member replica set you need two instances in a primary facility (hereafter, "Site A") and one member in a secondary facility (hereafter, "Site B".) Site A should be the same facility or very close to your primary application infrastructure (i.e. application servers, caching layer, users, etc.)

For a four-member replica set you need two members in Site A, two members in Site B (or one member in Site B and one member in Site C,) and a single *arbiter* in Site A.

For replica sets with additional members in the secondary facility or with multiple secondary facilities, the requirements are the same as above but with the following notes:

- Ensure that a majority of the *voting members* (page 288) are within Site A. This includes *secondary-only members* (page 286) and *arbiters* (page 288) For more information on the need to keep the voting majority on one site, see :ref'replica-set-elections-and-network-partitions'.
- If you deploy a replica set with an uneven number of members, deploy an *arbiter* (page 288) on Site A. The arbiter must be on site A to keep the majority there.

For all configurations in this tutorial, deploy each replica set member on a separate system. Although you may deploy more than one replica set member on a single system, doing so reduces the redundancy and capacity of the replica set. Such deployments are typically for testing purposes and beyond the scope of this tutorial.

Procedures

Deploy a Distributed Three-Member Replica Set

A geographically distributed three-member deployment has the following features:

- Each member of the replica set resides on its own machine, and the MongoDB processes all bind to port `27017`, which is the standard MongoDB port.
- Each member of the replica set must be accessible by way of resolvable DNS or hostnames in the following scheme:
  - `mongodb0.example.net`
  - `mongodb1.example.net`
  - `mongodb2.example.net`

  Configure DNS names appropriately, *or* set up your systems' `http://docs.mongodb.org/v2.2/etc/hosts` file to reflect this configuration. Ensure that one system (e.g. `mongodb2.example.net`) resides in Site B. Host all other systems in Site A.
- Ensure that network traffic can pass between all members in the network securely and efficiently. Consider the following:
  - Establish a virtual private network between the systems in Site A and Site B to encrypt all traffic between the sites and remains private. Ensure that your network topology routes all traffic between members within a single site over the local area network.
  - Configure authentication using `auth` (page 947) and `keyFile` (page 947), so that only servers and process with authentication can connect to the replica set.
  - Configure networking and firewall rules so that only traffic (incoming and outgoing packets) on the default MongoDB port (e.g. `27017`) from *within* your deployment.

    See Also:

    For more information on security and firewalls, see *Security Considerations for Replica Sets* (page 294).

- Specify run-time configuration on each system in a *configuration file* (page 944) stored in `http://docs.mongodb.org/v2.2/etc/mongodb.conf` or in a related location. *Do not* specify run-time configuration through command line options.

  For each MongoDB instance, use the following configuration, with values set appropriate to your systems:

  ```
  port = 27017

  bind_ip = 10.8.0.10

  dbpath = /srv/mongodb/

  fork = true

  replSet = rs0/mongodb0.example.net,mongodb1.example.net,mongodb2.example.net
  ```

  Modify `bind_ip` (page 945) to reflect a secure interface on your system that is able to access all other members of the set *and* that is accessible to all other members of the replica set. The DNS or host names need to point and resolve to this IP address. Configure network rules or a virtual private network (i.e. "VPN") to permit this access.

  Note: The portion of the `replSet` (page 952) following the `http://docs.mongodb.org/v2.2/` provides a "seed list" of known members of the replica set. `mongod` (page 897) uses this list to fetch configuration changes following restarts. It is acceptable to omit this section entirely, and have the `replSet` (page 952) option resemble:

  ```
  replSet = rs0
  ```

  For more documentation on the above run time configurations, as well as additional configuration options, see *Configuration File Options* (page 944).

To deploy a geographically distributed three-member set:

1. On each system start the `mongod` (page 897) process by issuing a command similar to following:

   ```
   mongod --config /etc/mongodb.conf
   ```

   Note: In production deployments you likely want to use and configure a *control script* to manage this process based on this command. Control scripts are beyond the scope of this document.

   ---

2. Open a `mongo` (page 908) shell connected to *one* of the `mongod` (page 897) instances:

   ```
   mongo
   ```

3. Use the `rs.initiate()` (page 860) method on *one* member to initiate a replica set consisting of the current member and using the default configuration:

   ```
   rs.initiate()
   ```

4. Display the current *replica configuration* (page 989):

   ```
   rs.conf()
   ```

5. Add the remaining members to the replica set by issuing a sequence of commands similar to the following. The example commands assume the current *primary* is `mongodb0.example.net`:

   ```
   rs.add("mongodb1.example.net")
   rs.add("mongodb2.example.net")
   ```

6. Make sure that you have configured the member located in Site B (i.e. `mongodb2.example.net`) as a *secondary-only member* (page 286):

   (a) Issue the following command to determine the `_id` (page 990) value for `mongodb2.example.net`:

   ```
   rs.conf()
   ```

   (b) In the `members` (page 989) array, save the `_id` (page 990) value. The example in the next step assumes this value is `2`.

   (c) In the `mongo` (page 908) shell connected to the replica set's primary, issue a command sequence similar to the following:

   ```
   cfg = rs.conf()
   cfg.members[2].priority = 0
   rs.reconfig(cfg)
   ```

   Note: In some situations, the `rs.reconfig()` (page 860) shell method can force the current primary to step down and causes an election. When the primary steps down, all clients will disconnect. This is the intended behavior. While, this typically takes 10-20 seconds, attempt to make these changes during scheduled maintenance periods.

   After these commands return you have a geographically distributed three-member replica set.

7. To check the status of your replica set, issue `rs.status()` (page 861).

See Also:

The documentation of the following shell functions for more information:

- `rs.initiate()` (page 860)
- `rs.conf()` (page 859)
- `rs.reconfig()` (page 860)
- `rs.add()` (page 858)

Deploy a Distributed Four-Member Replica Set

A geographically distributed four-member deployment has the following features:

- Each member of the replica set, except for the *arbiter* (see below), resides on its own machine, and the MongoDB processes all bind to port `27017`, which is the standard MongoDB port.
- Each member of the replica set must be accessible by way of resolvable DNS or hostnames in the following scheme:
  - `mongodb0.example.net`
  - `mongodb1.example.net`
  - `mongodb2.example.net`
  - `mongodb3.example.net`

  Configure DNS names appropriately, *or* set up your systems' `http://docs.mongodb.org/v2.2/etc/host` file to reflect this configuration. Ensure that one system (e.g. `mongodb2.example.net`) resides in Site B. Host all other systems in Site A.
- One host (e.g. `mongodb3.example.net`) will be an *arbiter* and can run on a system that is also used for an application server or some other shared purpose.

- There are three possible architectures for this replica set:
  - Two members in Site A, two *secondary-only members* (page 286) in Site B, and an arbiter in Site A.
  - Three members in Site A and one secondary-only member in Site B.
  - Two members in Site A, one secondary-only member in Site B, one secondary-only member in Site C, and an arbiter in site A.

  In most cases the first architecture is preferable because it is the least complex.
- Ensure that network traffic can pass between all members in the network securely and efficiently. Consider the following:
  - Establish a virtual private network between the systems in Site A and Site B (and Site C if it exists) to encrypt all traffic between the sites and remains private. Ensure that your network topology routes all traffic between members within a single site over the local area network.
  - Configure authentication using `auth` (page 947) and `keyFile` (page 947), so that only servers and process with authentication can connect to the replica set.
  - Configure networking and firewall rules so that only traffic (incoming and outgoing packets) on the default MongoDB port (e.g. `27017`) from *within* your deployment.

    See Also:

    For more information on security and firewalls, see *Security Considerations for Replica Sets* (page 294).
- Specify run-time configuration on each system in a *configuration file* (page 944) stored in `http://docs.mongodb.org/v2.2/etc/mongodb.conf` or in a related location. *Do not* specify run-time configuration through command line options.

  For each MongoDB instance, use the following configuration, with values set appropriate to your systems:

  ```
  port = 27017

  bind_ip = 10.8.0.10

  dbpath = /srv/mongodb/

  fork = true

  replSet = rs0/mongodb0.example.net,mongodb1.example.net,mongodb2.example.net,mongodb3.example.ne
  ```

  Modify `bind_ip` (page 945) to reflect a secure interface on your system that is able to access all other members of the set *and* that is accessible to all other members of the replica set. The DNS or host names need to point and resolve to this IP address. Configure network rules or a virtual private network (i.e. "VPN") to permit this access.

  Note: The portion of the `replSet` (page 952) following the `http://docs.mongodb.org/v2.2/` provides a "seed list" of known members of the replica set. `mongod` (page 897) uses this list to fetch configuration changes following restarts. It is acceptable to omit this section entirely, and have the `replSet` (page 952) option resemble:

  ```
  replSet = rs0
  ```

  For more documentation on the above run time configurations, as well as additional configuration options, see doc:*/reference/configuration-options*.

To deploy a geographically distributed four-member set:

1. On each system start the `mongod` (page 897) process by issuing a command similar to following:

   ```
   mongod --config /etc/mongodb.conf
   ```

   Note: In production deployments you likely want to use and configure a *control script* to manage this process based on this command. Control scripts are beyond the scope of this document.

2. Open a `mongo` (page 908) shell connected to this host:

   ```
   mongo
   ```

3. Use `rs.initiate()` (page 860) to initiate a replica set consisting of the current member and using the default configuration:

   ```
   rs.initiate()
   ```

4. Display the current *replica configuration* (page 989):

   ```
   rs.conf()
   ```

5. Add the remaining members to the replica set by issuing a sequence of commands similar to the following. The example commands assume the current *primary* is `mongodb0.example.net`:

   ```
   rs.add("mongodb1.example.net")
   rs.add("mongodb2.example.net")
   rs.add("mongodb3.example.net")
   ```

6. In the same shell session, issue the following command to add the arbiter (e.g. `mongodb4.example.net`):

   ```
   rs.addArb("mongodb4.example.net")
   ```

7. Make sure that you have configured each member located in Site B (e.g. `mongodb3.example.net`) as a *secondary-only member* (page 286):

   (a) Issue the following command to determine the `_id` (page 990) value for the member:

   ```
   rs.conf()
   ```

   (b) In the `members` (page 989) array, save the `_id` (page 990) value. The example in the next step assumes this value is `2`.

   (c) In the `mongo` (page 908) shell connected to the replica set's primary, issue a command sequence similar to the following:

   ```
   cfg = rs.conf()
   cfg.members[2].priority = 0
   rs.reconfig(cfg)
   ```

   Note: In some situations, the `rs.reconfig()` (page 860) shell method can force the current primary to step down and causes an election. When the primary steps down, all clients will disconnect. This is the intended behavior. While, this typically takes 10-20 seconds, attempt to make these changes during scheduled maintenance periods.

   After these commands return you have a geographically distributed four-member replica set.

8. To check the status of your replica set, issue `rs.status()` (page 861).

See Also:

The documentation of the following shell functions for more information:

- `rs.initiate()` (page 860)
- `rs.conf()` (page 859)
- `rs.reconfig()` (page 860)
- `rs.add()` (page 858)

Deploy a Distributed Set with More than Four Members

The procedure for deploying a geographically distributed set with more than four members is similar to the above procedures, with the following differences:

- Never deploy more than seven voting members.
- Use the procedure for a four-member set if you have an even number of members (see *Deploy a Distributed Four-Member Replica Set* (page 333)). Ensure that Site A always has a majority of the members by deploying the *arbiter* within Site A. For six member sets, deploy at least three voting members in addition to the arbiter in Site A, the remaining members in alternate sites.
- Use the procedure for a three-member set if you have an odd number of members (see *Deploy a Distributed Three-Member Replica Set* (page 331)). Ensure that Site A always has a majority of the members of the set. For example, if a set has five members, deploy three members within the primary facility and two members in other facilities.
- If you have a majority of the members of the set *outside* of Site A and the network partitions to prevent communication between sites, the current primary in Site A will step down, even if none of the members outside of Site A are eligible to become primary.

30.2 Replica Set Maintenance and Administration

30.2.1 Change the Size of the Oplog

The *oplog* exists internally as a *capped collection*, so you cannot modify its size in the course of normal operations. In most cases the *default oplog size* (page 282) is an acceptable size; however, in some situations you may need a larger or smaller oplog. For example, you might need to change the oplog size if your applications perform large numbers of multi-updates or deletes in short periods of time.

This tutorial describes how to resize the oplog. For a detailed explanation of oplog sizing, see the *Oplog* (page 282) topic in the *Replica Set Fundamental Concepts* (page 279) document. For details on the how oplog size affects *delayed members* and affects *replication lag*, see the *Delayed Members* (page 287) topic and the *Check the Replication Lag* (page 295) topic in *Replica Set Operation and Management* (page 285).

Overview

The following is an overview of the procedure for changing the size of the oplog:

1. Shut down the current *primary* instance in the *replica set* and then restart it on a different port and in "standalone" mode.
2. Create a backup of the old (current) oplog. This is optional.
3. Save the last entry from the old oplog.
4. Drop the old oplog.
5. Create a new oplog of a different size.

6. Insert the previously saved last entry from the old oplog into the new oplog.
7. Restart the server as a member of the replica set on its usual port.
8. Apply this procedure to any other member of the replica set that *could become* primary.

Procedure

The examples in this procedure use the following configuration:

- The active *replica set* is `rs0`.
- The replica set is running on port `27017`.
- The replica set is running with a `data directory` (page 947) of `http://docs.mongodb.org/v2.2/srv/mongodb`.

To change the size of the oplog for a replica set, use the following procedure for every member of the set that may become primary.

1. Shut down the `mongod` (page 897) instance and restart it in "standalone" mode running on a different port.

   Note: Shutting down the *primary* member of the set will trigger a failover situation and another member in the replica set will become primary. In most cases, it is least disruptive to modify the oplogs of all the secondaries before modifying the primary.

   To shut down the current primary instance, use a command that resembles the following:

   ```
   mongod --dbpath /srv/mongodb --shutdown
   ```

   To restart the instance on a different port and in "standalone" mode (i.e. without `replSet` (page 952) or *`--replSet`* (page 903)), use a command that resembles the following:

   ```
   mongod --port 37017 --dbpath /srv/mongodb
   ```

2. Backup the existing oplog on the standalone instance. Use the following sequence of commands:

   ```
   mongodump --db local --collection 'oplog.rs' --port 37017
   ```

   Note: You can restore the backup using the `mongorestore` (page 918) utility.

   Connect to the instance using the `mongo` (page 908) shell:

   ```
   mongo --port 37017
   ```

3. Save the last entry from the old (current) oplog.

   (a) In the `mongo` (page 908) shell, enter the following command to use the `local` database to interact with the oplog:

   ```
   use local
   ```

   (b) Use the `db.collection.save()` (page 840) operation to save the last entry in the oplog to a temporary collection:

   ```
   db.temp.save( db.oplog.rs.find( { }, { ts: 1, h: 1 } ).sort( {$natural : -1} ).limit(1).next
   ```

   You can see this oplog entry in the `temp` collection by issuing the following command:

```
db.temp.find()
```

4. Drop the old `oplog.rs` collection in the `local` database. Use the following command:

   ```
   db.oplog.rs.drop()
   ```

   This will return `true` on the shell.

5. Use the `create` (page 751) command to create a new oplog of a different size. Specify the `size` argument in bytes. A value of `2147483648` will create a new oplog that's 2 gigabytes:

   ```
   db.runCommand( { create : "oplog.rs", capped : true, size : 2147483648 } )
   ```

   Upon success, this command returns the following status:

   ```
   { "ok" : 1 }
   ```

6. Insert the previously saved last entry from the old oplog into the new oplog:

   ```
   db.oplog.rs.save( db.temp.findOne() )
   ```

   To confirm the entry is in the new oplog, issue the following command:

   ```
   db.oplog.rs.find()
   ```

7. Restart the server as a member of the replica set on its usual port:

   ```
   mongod --dbpath /srv/mongodb --shutdown
   mongod --replSet rs0 --dbpath /srv/mongodb
   ```

   The replica member will recover and "catch up" and then will be eligible for election to *primary*. To step down the "temporary" primary that took over when you initially shut down the server, use the `rs.stepDown()` (page 862) method. This will force an election for primary. If the server's *priority* (page 280) is higher than all other members in the set *and* if it has successfully "caught up," then it will likely become primary.

8. Repeat this procedure for all other members of the replica set that are or could become primary.

30.2.2 Force a Member to Become Primary

Synopsis

You can force a *replica set* member to become *primary* by giving it a higher `priority` (page 991) value than any other member in the set.

Optionally, you also can force a member never to become primary by setting its `priority` (page 991) value to `0`, which means the member can never seek *election* (page 280) as primary. For more information, see *Secondary-Only Members* (page 286).

Procedures

Force a Member to be Primary by Setting its Priority High

Changed in version 2.0. For more information on priorities, see *Member Priority* (page 280).

This procedure assumes your current *primary* is `m1.example.net` and that you'd like to instead make `m3.example.net` primary. The procedure also assumes you have a three-member *replica set* with the configuration below. For more information on configurations, see *Replica Set Configuration Use* (page 993).

This procedure assumes this configuration:

```
{
    "_id" : "rs",
    "version" : 7,
    "members" : [
        {
            "_id" : 0,
            "host" : "m1.example.net:27017"
        },
        {
            "_id" : 1,
            "host" : "m2.example.net:27017"
        },
        {
            "_id" : 2,
            "host" : "m3.example.net:27017"
        }
    ]
}
```

1. In the mongo (page 908) shell, use the following sequence of operations to make m3.example.net the primary:

   ```
   cfg = rs.conf()
   cfg.members[0].priority = 0.5
   cfg.members[1].priority = 0.5
   cfg.members[2].priority = 1
   rs.reconfig(cfg)
   ```

   This sets m3.example.net to have a higher local.system.replset.members[n].priority (page 991) value than the other mongod (page 897) instances.

   The following sequence of events occur:

   - m3.example.net and m2.example.net sync with m1.example.net (typically within 10 seconds).
   - m1.example.net sees that it no longer has highest priority and, in most cases, steps down. m1.example.net *does not* step down if m3.example.net's sync is far behind. In that case, m1.example.net waits until m3.example.net is within 10 seconds of its optime and then steps down. This minimizes the amount of time with no primary following failover.
   - The step down forces on election in which m3.example.net becomes primary based on its priority (page 991) setting.

2. Optionally, if m3.example.net is more than 10 seconds behind m1.example.net's optime, and if you don't need to have a primary designated within 10 seconds, you can force m1.example.net to step down by running:

   ```
   db.adminCommand({replSetStepDown:1000000, force:1})
   ```

   This prevents m1.example.net from being primary for 1,000,000 seconds, even if there is no other member that can become primary. When m3.example.net catches up with m1.example.net it will become primary.

   If you later want to make m1.example.net primary again while it waits for m3.example.net to catch up, issue the following command to make m1.example.net seek election again:

   ```
   rs.freeze()
   ```

The `rs.freeze()` (page 859) provides a wrapper around the `replSetFreeze` (page 788) database command.

Force a Member to be Primary Using Database Commands

Changed in version 1.8. Consider a *replica set* with the following members:

- `mdb0.example.net` - the current *primary*.
- `mdb1.example.net` - a *secondary*.
- `mdb2.example.net` - a secondary .

To force a member to become primary use the following procedure:

1. In a `mongo` (page 908) shell, run `rs.status()` (page 861) to ensure your replica set is running as expected.
2. In a `mongo` (page 908) shell connected to the `mongod` (page 897) instance running on `mdb2.example.net`, freeze `mdb2.example.net` so that it does not attempt to become primary for 120 seconds.

   ```
   rs.freeze(120)
   ```

3. In a `mongo` (page 908) shell connected the `mongod` (page 897) running on `mdb0.example.net`, step down this instance that the `mongod` (page 897) is not eligible to become primary for 120 seconds:

   ```
   rs.stepDown(120)
   ```

   `mdb1.example.net` becomes primary.

Note: During the transition, there is a short window where the set does not have a primary.

For more information, consider the `rs.freeze()` (page 859) and `rs.stepDown()` (page 862) methods that wrap the `replSetFreeze` (page 788) and `replSetStepDown` (page 790) commands.

30.2.3 Change Hostnames in a Replica Set

Synopsis

For most *replica sets* the hostnames [3] in the `host` (page 990) field never change. However, in some cases you must migrate some or all host names in a replica set as organizational needs change. This document presents two possible procedures for changing the hostnames in the `host` (page 990) field. Depending on your environments availability requirements, you may:

1. Make the configuration change without disrupting the availability of the replica set. While this ensures that your application will always be able to read and write data to the replica set, this procedure can take a long time and may incur downtime at the application layer. [4]

   For this procedure, see *Changing Hostnames while Maintaining the Replica Set's Availability* (page 341).

2. Stop all members of the replica set at once running on the "old" hostnames or interfaces, make the configuration changes, and then start the members at the new hostnames or interfaces. While the set will be totally unavailable during the operation, the total maintenance window is often shorter.

   For this procedure, see *Changing All Hostnames in Replica Set at Once* (page 343).

[3] Always use resolvable hostnames for the value of the `host` (page 990) field in the replica set configuration to avoid confusion and complexity.

[4] You will have to configure your applications so that they can connect to the replica set at both the old and new locations. This often requires a restart and reconfiguration at the application layer, which may affect the availability of your applications. This re-configuration is beyond the scope of this document and makes the *second option* (page 343) preferable when you must change the hostnames of *all* members of the replica set at once.

See Also:

- *Replica Set Configuration* (page 989)
- *Replica Set Reconfiguration Process* (page 993)
- `rs.conf()` (page 859) and `rs.reconfig()` (page 860)

And the following tutorials:

- *Deploy a Replica Set* (page 323)
- *Add Members to a Replica Set* (page 328)

Procedures

Given a *replica set* with three members:

- `database0.example.com:27017` (the *primary*)
- `database1.example.com:27017`
- `database2.example.com:27017`

And with the following `rs.conf()` (page 859) output:

```
{
    "_id" : "rs",
    "version" : 3,
    "members" : [
        {
            "_id" : 0,
            "host" : "database0.example.com:27017"
        },
        {
            "_id" : 1,
            "host" : "database1.example.com:27017"
        },
        {
            "_id" : 2,
            "host" : "database2.example.com:27017"
        }
    ]
}
```

The following procedures change the members' hostnames as follows:

- `mongodb0.example.net:27017` (the primary)
- `mongodb1.example.net:27017`
- `mongodb2.example.net:27017`

Use the most appropriate procedure for your deployment.

Changing Hostnames while Maintaining the Replica Set's Availability

This procedure uses the above *assumptions* (page 341).

1. For each *secondary* in the replica set, perform the following sequence of operations:
   (a) Stop the secondary.

(b) Restart the secondary at the new location.

(c) Open a mongo (page 908) shell connected to the replica set's primary. In our example, the primary runs on port 27017 so you would issue the following command:

```
mongo --port 27017
```

(d) Run the following reconfigure option, for the host (page 990) value where n is 1:

```
cfg = rs.conf()

cfg.members[1].host = "mongodb1.example.net:27017"

rs.reconfig(cfg)
```

See *Replica Set Configuration* (page 989) for more information.

(e) Make sure your client applications are able to access the set at the new location and that the secondary has a chance to catch up with the other members of the set.

Repeat the above steps for each non-primary member of the set.

2. Open a mongo (page 908) shell connected to the primary and step down the primary using replSetStepDown (page 790). In the mongo (page 908) shell, use the rs.stepDown() (page 862) wrapper, as follows:

```
rs.stepDown()
```

3. When the step down succeeds, shut down the primary.

4. To make the final configuration change, connect to the new primary in the mongo (page 908) shell and reconfigure the host (page 990) value where n is 0:

```
cfg = rs.conf()

cfg.members[0].host = "mongodb0.example.net:27017"

rs.reconfig(cfg)
```

5. Start the original primary.

6. Open a mongo (page 908) shell connected to the primary.

7. To confirm the new configuration, call rs.conf() (page 859) in the mongo (page 908) shell.

Your output should resemble:

```
{
    "_id" : "rs",
    "version" : 4,
    "members" : [
        {
            "_id" : 0,
            "host" : "mongodb0.example.net:27017"
        },
        {
            "_id" : 1,
            "host" : "mongodb1.example.net:27017"
        },
        {
            "_id" : 2,
            "host" : "mongodb2.example.net:27017"
```

```
        }
    ]
}
```

Changing All Hostnames in Replica Set at Once

This procedure uses the above *assumptions* (page 341).

1. Stop all members in the *replica set*.
2. Restart each member *on a different port* and *without* using the `--replSet` (page 903) run-time option. Changing the port number during maintenance prevents clients from connecting to this host while you perform maintenance. Use the member's usual `--dbpath` (page 899), which in this example is `http://docs.mongodb.org/v2.2/data/db1`. Use a command that resembles the following:

   ```
   mongod --dbpath /data/db1/ --port 37017
   ```

3. For each member of the replica set, perform the following sequence of operations:

   (a) Open a `mongo` (page 908) shell connected to the `mongod` (page 897) running on the new, temporary port. For example, for a member running on a temporary port of `37017`, you would issue this command:

   ```
   mongo --port 37017
   ```

   (b) Edit the replica set configuration manually. The replica set configuration is the only document in the `system.replset` collection in the `local` database. Edit the replica set configuration with the new hostnames and correct ports for all the members of the replica set. Consider the following sequence of commands to change the hostnames in a three-member set:

   ```
   use local

   cfg = db.system.replset.findOne( { "_id": "rs" } )

   cfg.members[0].host = "mongodb0.example.net:27017"

   cfg.members[1].host = "mongodb1.example.net:27017"

   cfg.members[2].host = "mongodb2.example.net:27017"

   db.system.replset.update( { "_id": "rs" } , cfg )
   ```

   (c) Stop the `mongod` (page 897) process on the member.

4. After re-configuring all members of the set, start each `mongod` (page 897) instance in the normal way: use the usual port number and use the `--replSet` (page 903) option. For example:

   ```
   mongod --dbpath /data/db1/ --port 27017 --replSet rs
   ```

5. Connect to one of the `mongod` (page 897) instances using the `mongo` (page 908) shell. For example:

   ```
   mongo --port 27017
   ```

6. To confirm the new configuration, call `rs.conf()` (page 859) in the `mongo` (page 908) shell.

   Your output should resemble:

   ```
   {
       "_id" : "rs",
       "version" : 4,
   ```

```
    "members" : [
        {
            "_id" : 0,
            "host" : "mongodb0.example.net:27017"
        },
        {
            "_id" : 1,
            "host" : "mongodb1.example.net:27017"
        },
        {
            "_id" : 2,
            "host" : "mongodb2.example.net:27017"
        }
    ]
}
```

30.2.4 Convert a Secondary to an Arbiter

If you have a *secondary* in a *replica set* that no longer needs to hold a copy of the data *but* that you want to retain in the set to ensure that the replica set will be able to *elect a primary* (page 280), you can convert the secondary into an *arbiter* (page 288). This document provides two equivalent procedures for this process.

Synopsis

Both of the following procedures are operationally equivalent. Choose whichever procedure you are most comfortable with:

1. You may operate the arbiter on the same port as the former secondary. In this procedure, you must shut down the secondary and remove its data before restarting and reconfiguring it as an arbiter.

   For this procedure, see *Convert a Secondary to an Arbiter and Reuse the Port Number* (page 344).

2. Run the arbiter on a new port. In this procedure, you can reconfigure the server as an arbiter before shutting down the instance running as a secondary.

   For this procedure, see *Convert a Secondary to an Arbiter Running on a New Port Number* (page 345).

See Also:

- *Arbiters* (page 288)
- `rs.addArb()` (page 859)
- *Replica Set Operation and Management* (page 285)

Procedures

Convert a Secondary to an Arbiter and Reuse the Port Number

1. If your application is connecting directly to the secondary, modify the application so that MongoDB queries don't reach the secondary.
2. Shut down the secondary.
3. Remove the *secondary* from the *replica set* by calling the `rs.remove()` (page 861) method. Perform this operation while connected to the current *primary* in the `mongo` (page 908) shell:

```
rs.remove("<hostname><:port>")
```

4. Verify that the replica set no longer includes the secondary by calling the `rs.conf()` (page 859) method in the `mongo` (page 908) shell:

   ```
   rs.conf()
   ```

5. Move the secondary's data directory to an archive folder. For example:

   ```
   mv /data/db /data/db-old
   ```

   Optional

   You may remove the data instead.

6. Create a new, empty data directory to point to when restarting the `mongod` (page 897) instance. You can reuse the previous name. For example:

   ```
   mkdir /data/db
   ```

7. Restart the `mongod` (page 897) instance for the secondary, specifying the port number, the empty data directory, and the replica set. You can use the same port number you used before. Issue a command similar to the following:

   ```
   mongod --port 27021 --dbpath /data/db --replSet rs
   ```

8. In the `mongo` (page 908) shell convert the secondary to an arbiter using the `rs.addArb()` (page 859) method:

   ```
   rs.addArb("<hostname><:port>")
   ```

9. Verify the arbiter belongs to the replica set by calling the `rs.conf()` (page 859) method in the `mongo` (page 908) shell.

   ```
   rs.conf()
   ```

   The arbiter member should include the following:

   ```
   "arbiterOnly" : true
   ```

Convert a Secondary to an Arbiter Running on a New Port Number

1. If your application is connecting directly to the secondary or has a connection string referencing the secondary, modify the application so that MongoDB queries don't reach the secondary.
2. Create a new, empty data directory to be used with the new port number. For example:

   ```
   mkdir /data/db-temp
   ```

3. Start a new `mongod` (page 897) instance on the new port number, specifying the new data directory and the existing replica set. Issue a command similar to the following:

   ```
   mongod --port 27021 --dbpath /data/db-temp --replSet rs
   ```

4. In the `mongo` (page 908) shell connected to the current primary, convert the new `mongod` (page 897) instance to an arbiter using the `rs.addArb()` (page 859) method:

   ```
   rs.addArb("<hostname><:port>")
   ```

5. Verify the arbiter has been added to the replica set by calling the `rs.conf()` (page 859) method in the `mongo` (page 908) shell.

   ```
   rs.conf()
   ```

   The arbiter member should include the following:

   ```
   "arbiterOnly" : true
   ```

6. Shut down the secondary.

7. Remove the *secondary* from the *replica set* by calling the `rs.remove()` (page 861) method in the `mongo` (page 908) shell:

   ```
   rs.remove("<hostname><:port>")
   ```

8. Verify that the replica set no longer includes the old secondary by calling the `rs.conf()` (page 859) method in the `mongo` (page 908) shell:

   ```
   rs.conf()
   ```

9. Move the secondary's data directory to an archive folder. For example:

   ```
   mv /data/db /data/db-old
   ```

Optional

You may remove the data instead.

30.2.5 Reconfigure a Replica Set with Unavailable Members

To reconfigure a *replica set* when a **minority** of members are unavailable, use the `rs.reconfig()` (page 860) operation on the current *primary*, following the example in the *Replica Set Reconfiguration Procedure* (page 993).

This document provides the following options for re-configuring a replica set when a **majority** of members are *not* accessible:

- *Reconfigure by Forcing the Reconfiguration* (page 346)
- *Reconfigure by Replacing the Replica Set* (page 347)

You may need to use one of these procedures, for example, in a geographically distributed replica set, where *no* local group of members can reach a majority. See *Elections and Network Partitions* (page 300) for more information on this situation.

Reconfigure by Forcing the Reconfiguration

Changed in version 2.0. This procedure lets you recover while a majority of *replica set* members are down or unreachable. You connect to any surviving member and use the `force` option to the `rs.reconfig()` (page 860) method.

The `force` option forces a new configuration onto the. Use this procedure only to recover from catastrophic interruptions. Do not use `force` every time you reconfigure. Also, do not use the `force` option in any automatic scripts and do not use `force` when there is still a *primary*.

To force reconfiguration:

1. Back up a surviving member.

2. Connect to a surviving member and save the current configuration. Consider the following example commands for saving the configuration:

   ```
   cfg = rs.conf()

   printjson(cfg)
   ```

3. On the same member, remove the down and unreachable members of the replica set from the `members` (page 989) array by setting the array equal to the surviving members alone. Consider the following example, which uses the `cfg` variable created in the previous step:

   ```
   cfg.members = [cfg.members[0] , cfg.members[4] , cfg.members[7]]
   ```

4. On the same member, reconfigure the set by using the `rs.reconfig()` (page 860) command with the `force` option set to `true`:

   ```
   rs.reconfig(cfg, {force : true})
   ```

   This operation forces the secondary to use the new configuration. The configuration is then propagated to all the surviving members listed in the `members` array. The replica set then elects a new primary.

   Note: When you use `force : true`, the version number in the replica set configuration increases significantly, by tens or hundreds of thousands. This is normal and designed to prevent set version collisions if you accidentally force re-configurations on both sides of a network partition and then the network partitioning ends.

   ---

5. If the failure or partition was only temporary, shut down or decommission the removed members as soon as possible.

Reconfigure by Replacing the Replica Set

Use the following procedure **only** for versions of MongoDB prior to version 2.0. If you're running MongoDB 2.0 or later, use the above procedure, *Reconfigure by Forcing the Reconfiguration* (page 346).

These procedures are for situations where a *majority* of the *replica set* members are down or unreachable. If a majority is *running*, then skip these procedures and instead use the `rs.reconfig()` (page 860) command according to the examples in *Example Reconfiguration Operations* (page 993).

If you run a pre-2.0 version and a majority of your replica set is down, you have the two options described here. Both involve replacing the replica set.

Reconfigure by Turning Off Replication

This option replaces the *replica set* with a *standalone* server.

1. Stop the surviving `mongod` (page 897) instances. To ensure a clean shutdown, use an existing *control script* or an invocation that resembles the following:

   ```
   mongod --dbpath /data/db/ --shutdown
   ```

   Set *`--dbpath`* (page 899) to the data directory of your `mongod` (page 897) instance.

2. Create a backup of the data directory (i.e. `dbpath` (page 947)) of the surviving members of the set.

   Optional

   If you have a backup of the database you may instead remove this data.

   ---

3. Restart one of the mongod (page 897) instances *without* the *--replSet* (page 903) parameter.

   The data is now accessible and provided by a single server that is not a replica set member. Clients can use this server for both reads and writes.

When possible, re-deploy a replica set to provide redundancy and to protect your deployment from operational interruption.

Reconfigure by "Breaking the Mirror"

This option selects a surviving *replica set* member to be the new *primary* and to "seed" a new replica set. In the following procedure, the new primary is db0.example.net. MongoDB copies the data from db0.example.net to all the other members.

1. Stop the surviving mongod (page 897) instances. To ensure a clean shutdown, use an existing *control script* or an invocation that resembles the following:

   ```
   mongod --dbpath /data/db/ --shutdown
   ```

   Set *--dbpath* (page 899) to the data directory of your mongod (page 897) instance.

2. Move the data directories (i.e. dbpath (page 947)) for all the members except db0.example.net, so that all the members except db0.example.net have empty data directories. For example:

   ```
   mv /data/db /data/db-old
   ```

3. Move the data files for local database (i.e. local.*) so that db0.example.net has no local database. For example

   ```
   mkdir /data/local-old
   mv /data/db/local* /data/local-old/
   ```

4. Start each member of the replica set normally.

5. Connect to db0.example.net in a mongo (page 908) shell and run rs.initiate() (page 860) to initiate the replica set.

6. Add the other set members using rs.add() (page 858). For example, to add a member running on db1.example.net at port 27017, issue the following command:

   ```
   rs.add("db1.example.net:27017")
   ```

   MongoDB performs an initial sync on the added members by copying all data from db0.example.net to the added members.

30.2.6 Recover MongoDB Data following Unexpected Shutdown

If MongoDB does not shutdown cleanly [5] the on-disk representation of the data files will likely reflect an inconsistent state which could lead to data corruption. [6]

To prevent data inconsistency and corruption, always shut down the database cleanly and use the *durability journaling* (page 948). The journal writes data to disk every 100 milliseconds by default and ensures that MongoDB can recover to a consistent state even in the case of an unclean shutdown due to power loss or other system failure.

[5] To ensure a clean shut down, use the *mongod --shutdown* (page 902) option, your control script, "Control-C" (when running mongod (page 897) in interactive mode,) or kill $(pidof mongod) or kill -2 $(pidof mongod).

[6] You can also use the db.collection.validate() (page 844) method to test the integrity of a single collection. However, this process is time consuming, and without journaling you can safely assume that the data is in an invalid state and you should either run the repair operation or resync from an intact member of the replica set.

If you are *not* running as part of a *replica set* **and** do *not* have journaling enabled, use the following procedure to recover data that may be in an inconsistent state. If you are running as part of a replica set, you should *always* restore from a backup or restart the `mongod` (page 897) instance with an empty `dbpath` (page 947) and allow MongoDB to perform an initial sync to restore the data.

See Also:

The *Administration* (page 31) documents, including *Replica Set Syncing* (page 315), and the documentation on the `repair` (page 950), `repairpath` (page 950), and `journal` (page 948) settings.

Process

Indications

When you are aware of a `mongod` (page 897) instance running without journaling that stops unexpectedly **and** you're not running with replication, you should always run the repair operation before starting MongoDB again. If you're using replication, then restore from a backup and allow replication to perform an initial *sync* (page 315) to restore data.

If the `mongod.lock` file in the data directory specified by `dbpath` (page 947), `http://docs.mongodb.org/v2.2/data/db` by default, is *not* a zero-byte file, then `mongod` (page 897) will refuse to start, and you will find a message that contains the following line in your MongoDB log our output:

```
Unclean shutdown detected.
```

This indicates that you need to remove the lockfile and run repair. If you run repair when the `mongodb.lock` file exists without the *`mongod --repairpath`* (page 902) option, you will see a message that contains the following line:

```
old lock file: /data/db/mongod.lock. probably means unclean shutdown
```

You must remove the lockfile **and** run the repair operation before starting the database normally using the following procedure:

Overview

Warning: Recovering a member of a replica set.
Do not use this procedure to recover a member of a *replica set*. Instead you should either restore from a *backup* (page 67) or perform an initial sync using data from an intact member of the set, as described in *Resyncing a Member of a Replica Set* (page 293).

There are two processes to repair data files that result from an unexpected shutdown:

1. Use the *`--repair`* (page 901) option in conjunction with the *`--repairpath`* (page 902) option. `mongod` (page 897) will read the existing data files, and write the existing data to new data files. This does not modify or alter the existing data files.

   You do not need to remove the `mongod.lock` file before using this procedure.

2. Use the *`--repair`* (page 901) option. `mongod` (page 897) will read the existing data files, write the existing data to new files and replace the existing, possibly corrupt, files with new files.

   You must remove the `mongod.lock` file before using this procedure.

Note: *`--repair`* (page 901) functionality is also available in the shell with the `db.repairDatabase()` (page 853) helper for the `repairDatabase` (page 787) command.

Procedures

To repair your data files using the *--repairpath* (page 902) option to preserve the original data files unmodified:

1. Start mongod (page 897) using *--repair* (page 901) to read the existing data files.

   ```
   mongod --dbpath /data/db --repair --repairpath /data/db0
   ```

   When this completes, the new repaired data files will be in the http://docs.mongodb.org/v2.2/data/db0 directory.

2. Start mongod (page 897) using the following invocation to point the dbpath (page 947) at http://docs.mongodb.org/v2.2/data/db0:

   ```
   mongod --dbpath /data/db0
   ```

   Once you confirm that the data files are operational you may delete or archive the data files in the http://docs.mongodb.org/v2.2/data/db directory.

To repair your data files without preserving the original files, do not use the *--repairpath* (page 902) option, as in the following procedure:

1. Remove the stale lock file:

   ```
   rm /data/db/mongod.lock
   ```

   Replace http://docs.mongodb.org/v2.2/data/db with your dbpath (page 947) where your MongoDB instance's data files reside.

   Warning: After you remove the mongod.lock file you *must* run the *--repair* (page 901) process before using your database.

2. Start mongod (page 897) using *--repair* (page 901) to read the existing data files.

   ```
   mongod --dbpath /data/db --repair
   ```

   When this completes, the repaired data files will replace the original data files in the http://docs.mongodb.org/v2.2/data/db directory.

3. Start mongod (page 897) using the following invocation to point the dbpath (page 947) at http://docs.mongodb.org/v2.2/data/db:

   ```
   mongod --dbpath /data/db
   ```

mongod.lock

In normal operation, you should **never** remove the mongod.lock file and start mongod (page 897). Instead consider the one of the above methods to recover the database and remove the lock files. In dire situations you can remove the lockfile, and start the database using the possibly corrupt files, and attempt to recover data from the database; however, it's impossible to predict the state of the database in these situations.

If you are not running with journaling, and your database shuts down unexpectedly for *any* reason, you should always proceed *as if* your database is in an inconsistent and likely corrupt state. If at all possible restore from *backup* (page 67) or, if running as a *replica set*, restore by performing an initial sync using data from an intact member of the set, as described in *Resyncing a Member of a Replica Set* (page 293).

CHAPTER 31

Replica Set Reference Material

Additionally, consider the following reference listed in this section. The following describes the replica set configuration object:

- *Replica Set Configuration* (page 989)

The following describe MongoDB output and status related to replication:

- *Replica Set Status Reference* (page 987)
- *Replication Info Reference* (page 997)

Finally, consider the following quick references of the commands and operations available for replica set administration and use:

31.1 Replica Set Commands

This reference collects documentation for all *JavaScript methods* (page 351) for the `mongo` (page 908) shell that support *replica set* functionality, as well as all *database commands* (page 355) related to replication function.

See *Replication* (page 277), for a list of all replica set documentation.

31.1.1 JavaScript Methods

The following methods apply to replica sets. For a complete list of all methods, see *JavaScript Methods* (page 800).

`rs.status()`

Returns A *document* with status information.

This output reflects the current status of the replica set, using data derived from the heartbeat packets sent by the other members of the replica set.

This method provides a wrapper around the `replSetGetStatus` (page 788) *database command*.

See Also:

"*Replica Set Status Reference* (page 987)" for documentation of this output.

db.**isMaster**()

Returns a status document with fields that includes the `ismaster` field that reports if the current node is the *primary* node, as well as a report of a subset of current replica set configuration.

This function provides a wrapper around the *database command* `isMaster` (page 772)

rs.**initiate**(*configuration*)

Parameters

- **configuration** – Optional. A *document* that specifies the configuration of a replica set. If not specified, MongoDB will use a default configuration.

Initiates a replica set. Optionally takes a configuration argument in the form of a *document* that holds the configuration of a replica set. Consider the following model of the most basic configuration for a 3-member replica set:

```
{
    _id : <setname>,
     members : [
         {_id : 0, host : <host0>},
         {_id : 1, host : <host1>},
         {_id : 2, host : <host2>},
     ]
}
```

This function provides a wrapper around the "`replSetInitiate` (page 789)" *database command*.

rs.**conf**()

Returns a *document* that contains the current *replica set* configuration object.

rs.**config**()

`rs.config()` (page 859) is an alias of `rs.conf()` (page 859).

rs.**reconfig**(*configuration*[, *force*])

Parameters

- **configuration** – A *document* that specifies the configuration of a replica set.
- **force** – Optional. Specify `{ force: true }` as the force parameter to force the replica set to accept the new configuration even if a majority of the members are not accessible. Use with caution, as this can lead to *rollback* situations.

Initializes a new *replica set* configuration. This function will disconnect the shell briefly and forces a reconnection as the replica set renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.reconfig()` (page 860) provides a wrapper around the "`replSetReconfig` (page 790)" *database command*.

`rs.reconfig()` (page 860) overwrites the existing replica set configuration. Retrieve the current configuration object with `rs.conf()` (page 859), modify the configuration as needed and then use `rs.reconfig()` (page 860) to submit the modified configuration object.

To reconfigure a replica set, use the following sequence of operations:

```
conf = rs.conf()

// modify conf to change configuration

rs.reconfig(conf)
```

If you want to force the reconfiguration if a majority of the set isn't connected to the current member, or you're issuing the command against a secondary, use the following form:

```
conf = rs.conf()

// modify conf to change configuration

rs.reconfig(conf, { force: true } )
```

Warning: Forcing a `rs.reconfig()` (page 860) can lead to *rollback* situations and other difficult to recover from situations. Exercise caution when using this option.

See Also:

"*Replica Set Configuration* (page 989)" and "*Replica Set Operation and Management* (page 285)".

`rs.add`(*hostspec*, *arbiterOnly*)

Specify one of the following forms:

Parameters

- **host** (*string,document*) – Either a string or a document. If a string, specifies a host (and optionally port-number) for a new host member for the replica set; MongoDB will add this host with the default configuration. If a document, specifies any attributes about a member of a replica set.
- **arbiterOnly** (*boolean*) – Optional. If `true`, this host is an arbiter. If the second argument evaluates to `true`, as is the case with some *documents*, then this instance will become an arbiter.

Provides a simple method to add a member to an existing *replica set*. You can specify new hosts in one of two ways:

1. as a "hostname" with an optional port number to use the default configuration as in the *Add a Member to an Existing Replica Set* (page 329) example.
2. as a configuration *document*, as in the *Add a Member to an Existing Replica Set (Alternate Procedure)* (page 330) example.

This function will disconnect the shell briefly and forces a reconnection as the replica set renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.add()` (page 858) provides a wrapper around some of the functionality of the "`replSetReconfig` (page 790)" *database command* and the corresponding shell helper `rs.reconfig()` (page 860). See the *Replica Set Configuration* (page 989) document for full documentation of all replica set configuration options.

Example

To add a `mongod` (page 897) accessible on the default port `27017` running on the host `mongodb3.example.net`, use the following `rs.add()` (page 858) invocation:

```
rs.add('mongodb3.example.net:27017')
```

If `mongodb3.example.net` is an arbiter, use the following form:

```
rs.add('mongodb3.example.net:27017', true)
```

To add `mongodb3.example.net` as a *secondary-only* (page 286) member of set, use the following form of `rs.add()` (page 858):

```
rs.add( { "_id": "3", "host": "mongodbd3.example.net:27017", "priority": 0 } )
```

Replace, `3` with the next unused `_id` value in the replica set. See `rs.conf()` (page 859) to see the existing `_id` values in the replica set configuration document.

See the *Replica Set Configuration* (page 989) and *Replica Set Operation and Management* (page 285) documents for more information.

`rs.addArb(hostname)`

Parameters

- **host** (*string*) – Specifies a host (and optionally port-number) for a arbiter member for the replica set.

Adds a new *arbiter* to an existing replica set.

This function will disconnect the shell briefly and forces a reconnection as the replica set renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.stepDown(seconds)`

Parameters

- **seconds** (*init*) – Specify the duration of this operation. If not specified the command uses the default value of 60 seconds.

Returns disconnects shell.

Forces the current replica set member to step down as *primary* and then attempt to avoid election as primary for the designated number of seconds. Produces an error if the current node is not primary.

This function will disconnect the shell briefly and forces a reconnection as the *replica set* renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.stepDown()` (page 862) provides a wrapper around the *database command* `replSetStepDown` (page 790).

`rs.freeze(seconds)`

Parameters

- **seconds** (*init*) – Specify the duration of this operation.

Forces the current node to become ineligible to become primary for the period specified.

`rs.freeze()` (page 859) provides a wrapper around the *database command* `replSetFreeze` (page 788).

`rs.remove(hostname)`

Parameters

- **hostname** – Specify one of the existing hosts to remove from the current replica set.

Removes the node described by the `hostname` parameter from the current *replica set*. This function will disconnect the shell briefly and forces a reconnection as the *replica set* renegotiates negotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

Note: Before running the `rs.remove()` (page 861) operation, you must *shut down* the replica set member that you're removing. Changed in version 2.2: This procedure is no longer required when using `rs.remove()` (page 861), but it remains good practice.

`rs.slaveOk()`
Provides a shorthand for the following operation:

```
db.getMongo().setSlaveOk()
```

This allows the current connection to allow read operations to run on *secondary* nodes. See the `readPref()` (page 811) method for more fine-grained control over *read preference* (page 306) in the `mongo` (page 908) shell.

`db.isMaster()`
Returns a status document with fields that includes the `ismaster` field that reports if the current node is the *primary* node, as well as a report of a subset of current replica set configuration.

This function provides a wrapper around the *database command* `isMaster` (page 772)

`rs.help()`
Returns a basic help text for all of the *replication* (page 279) related shell functions.

`rs.syncFrom()`
New in version 2.2. Provides a wrapper around the `replSetSyncFrom` (page 791), which allows administrators to configure the member of a replica set that the current member will pull data from. Specify the name of the member you want to replicate from in the form of `[hostname]:[port]`.

See `replSetSyncFrom` (page 791) for more details.

31.1.2 Database Commands

The following commands apply to replica sets. For a complete list of all commands, see *Database Commands Quick Reference* (page 885).

isMaster
The `isMaster` (page 772) command provides a basic overview of the current replication configuration. MongoDB *drivers* and *clients* use this command to determine what kind of member they're connected to and to discover additional members of a *replica set*. The `db.isMaster()` (page 850) method provides a wrapper around this database command.

The command takes the following form:

```
{ isMaster: 1 }
```

This command returns a *document* containing the following fields:

`isMaster.setname`
The name of the current replica set, if applicable.

`isMaster.ismaster`
A boolean value that reports when this node is writable. If `true`, then the current node is either a *primary* in a *replica set*, a *master* in a master-slave configuration, or a standalone `mongod` (page 897).

`isMaster.secondary`
A boolean value that, when `true`, indicates that the current member is a *secondary* member of a *replica set*.

`isMaster.hosts`
An array of strings in the format of "`[hostname]:[port]`" listing all members of the *replica set* that are not "*hidden*".

`isMaster.arbiter`
An array of strings in the format of "`[hostname]:[port]`" listing all members of the *replica set* that are *arbiters*

Only appears in the `isMaster` (page 772) response for replica sets that have arbiter members.

isMaster.**arbiterOnly**
A boolean value that, when `true` indicates that the current instance is an *arbiter*.

`arbiterOnly` (page 773) only appears in the `isMaster` (page 772) response from arbiters.

isMaster.**primary**
The `[hostname]:[port]` for the current *replica set primary*, if applicable.

isMaster.**me**
The `[hostname]:[port]` of the node responding to this command.

isMaster.**maxBsonObjectSize**
The maximum permitted size of a *BSON* object in bytes for this `mongod` (page 897) process. If not provided, clients should assume a max size of "`4 * 1024 * 1024`".

isMaster.**localTime**
New in version 2.1.1. Returns the local server time in UTC. This value is a *ISOdate*. You can use the `toString()` JavaScript method to convert this value to a local date string, as in the following example:

```
db.isMaster().localTime.toString();
```

resync
The `resync` (page 792) command forces an out-of-date slave `mongod` (page 897) instance to re-synchronize itself. Note that this command is relevant to master-slave replication only. It does not apply to replica sets.

> **Warning:** This command obtains a global write lock and will block other operations until it has completed.

replSetFreeze
The `replSetFreeze` (page 788) command prevents a replica set member from seeking election for the specified number of seconds. Use this command in conjunction with the `replSetStepDown` (page 790) command to make a different node in the replica set a primary.

The `replSetFreeze` (page 788) command uses the following syntax:

```
{ replSetFreeze: <seconds> }
```

If you want to unfreeze a replica set member before the specified number of seconds has elapsed, you can issue the command with a seconds value of `0`:

```
{ replSetFreeze: 0 }
```

Restarting the `mongod` (page 897) process also unfreezes a replica set member.

`replSetFreeze` (page 788) is an administrative command, and you must issue the it against the *admin database*.

replSetGetStatus
The `replSetGetStatus` command returns the status of the replica set from the point of view of the current server. You must run the command against the *admin database*. The command has the following prototype format:

```
{ replSetGetStatus: 1 }
```

However, you can also run this command from the shell like so:

```
rs.status()
```

See Also:

"*Replica Set Status Reference* (page 987)" and "*Replica Set Fundamental Concepts* (page 279)"

replSetInitiate

The replSetInitiate (page 789) command initializes a new replica set. Use the following syntax:

```
{ replSetInitiate : <config_document> }
```

The <config_document> is a *document* that specifies the replica set's configuration. For instance, here's a config document for creating a simple 3-member replica set:

```
{
    _id : <setname>,
     members : [
         {_id : 0, host : <host0>},
         {_id : 1, host : <host1>},
         {_id : 2, host : <host2>},
     ]
}
```

A typical way of running this command is to assign the config document to a variable and then to pass the document to the rs.initiate() (page 860) helper:

```
config = {
    _id : "my_replica_set",
     members : [
         {_id : 0, host : "rs1.example.net:27017"},
         {_id : 2, host : "rs2.example.net:27017"},
         {_id : 2, host : "rs3.example.net", arbiterOnly: true},
     ]
}

rs.initiate(config)
```

```
Notice that omitting the port cause the host to use the default port
of 27017. Notice also that you can specify other options in the config
documents such as the ``arbiterOnly`` setting in this example.
```

See Also:

"*Replica Set Configuration* (page 989)," "*Replica Set Operation and Management* (page 285)," and "*Replica Set Reconfiguration* (page 993)."

replSetMaintenance

The replSetMaintenance (page 789) admin command enables or disables the maintenance mode for a *secondary* member of a *replica set*.

The command has the following prototype form:

```
{ replSetMaintenance: <boolean> }
```

Consider the following behavior when running the replSetMaintenance (page 789) command:

- You cannot run the command on the Primary.
- You must run the command against the admin database.
- When enabled replSetMaintenance: 1, the member enters the RECOVERING state. While the secondary is RECOVERING:
  - The member is not accessible for read operations.
  - The member continues to sync its *oplog* from the Primary.

replSetReconfig

The replSetReconfig (page 790) command modifies the configuration of an existing replica set. You can

use this command to add and remove members, and to alter the options set on existing members. Use the following syntax:

```
{ replSetReconfig: <new_config_document>, force: false }
```

You may also run the command using the shell's `rs.reconfig()` (page 860) method.

Be aware of the following `replSetReconfig` (page 790) behaviors:

- You must issue this command against the *admin database* of the current primary member of the replica set.
- You can optionally force the replica set to accept the new configuration by specifying `force: true`. Use this option if the current member is not primary or if a majority of the members of the set are not accessible.

  Warning: Forcing the `replSetReconfig` (page 790) command can lead to a *rollback* situation. Use with caution.

  Use the force option to restore a replica set to new servers with different hostnames. This works even if the set members already have a copy of the data.
- A majority of the set's members must be operational for the changes to propagate properly.
- This command can cause downtime as the set renegotiates primary-status. Typically this is 10-20 seconds, but could be as long as a minute or more. Therefore, you should attempt to reconfigure only during scheduled maintenance periods.
- In some cases, `replSetReconfig` (page 790) forces the current primary to step down, initiating an election for primary among the members of the replica set. When this happens, the set will drop all current connections.

Note: `replSetReconfig` (page 790) obtains a special mutually exclusive lock to prevent more than one `replSetReconfig` (page 790) operation from occurring at the same time.

`replSetSyncFrom`

New in version 2.2.

Options

- **host** – Specifies the name and port number of the replica set member that this member replicates from. Use the `[hostname]:[port]` form.

`replSetSyncFrom` (page 791) allows you to explicitly configure which host the current `mongod` (page 897) will poll *oplog* entries from. This operation may be useful for testing different patterns and in situations where a set member is not replicating from the host you want. The member to replicate from must be a valid source for data in the set.

A member cannot replicate from:

- itself.
- an arbiter, because arbiters do not hold data.
- a member that does not build indexes.
- an unreachable member.
- a `mongod` (page 897) instance that is not a member of the same replica set.

If you attempt to replicate from a member that is more than 10 seconds behind the current member, `mongod` (page 897) will return and log a warning, but it still *will* replicate from the member that is behind.

If you run `rs.syncFrom()` (page 862) during initial sync, MongoDB produces no error messages, but the sync target will not change until after the initial sync operation.

The command has the following prototype form:

```
{ replSetSyncFrom: "[hostname]:[port]" }
```

To run the command in the `mongo` (page 908) shell, use the following invocation:

```
db.adminCommand( { replSetSyncFrom: "[hostname]:[port]" } )
```

You may also use the `rs.syncFrom()` (page 862) helper in the `mongo` (page 908) shell, in an operation with the following form:

```
rs.syncFrom("[hostname]:[port]")
```

Note: `replSetSyncFrom` (page 791) and `rs.syncFrom()` (page 862) provide a temporary override of default behavior. If:

- the `mongod` (page 897) instance restarts or
- the connection to the sync target closes;

then, the `mongod` (page 897) instance will revert to the default sync logic and target.

31.2 Replica Set Features and Version Compatibility

Note: This table is for archival purposes and does not list all features of *replica sets*. Always use the latest stable release of MongoDB in production deployments.

Features	Version
Slave Delay	1.6.3
Hidden	1.7
`replSetFreeze` (page 788) and `replSetStepDown` (page 790)	1.7.3
Replicated ops in `mongostat` (page 931)	1.7.3
Syncing from Secondaries	1.8.0
Authentication	1.8.0
Replication from Nearest Server (by ping Time)	2.0
`replSetSyncFrom` (page 791) support for replicating from specific members.	2.2

Additionally:

- 1.8-series secondaries can replicate from 1.6-series primaries.
- 1.6-series secondaries cannot replicate from 1.8-series primaries.

Part VIII

Sharding

Sharding distributes a single logical database system across a cluster of machines. Sharding uses range-based portioning to distribute *documents* based on a specific *shard key*.

For a general introduction to sharding, cluster operations, and relevant implications and administration see: *FAQ: Sharding with MongoDB* (page 659).

Sharded Cluster Use and Operation

The documents in this section introduce sharded clusters, their operation, functioning, and use. If you are unfamiliar with data partitioning, or MongoDB's sharding implementation begin with these documents:

32.1 Sharded Cluster Overview

Sharding is MongoDB's approach to scaling out. Sharding partitions a collection and stores the different portions on different machines. When a database's collections become too large for existing storage, you need only add a new machine. Sharding automatically distributes collection data to the new server.

Sharding automatically balances data and load across machines. Sharding provides additional write capacity by distributing the write load over a number of `mongod` (page 897) instances. Sharding allows users to increase the potential amount of data in the *working set*.

32.1.1 How Sharding Works

To run sharding, you set up a sharded cluster. For a description of sharded clusters, see *Sharded Cluster Administration* (page 368).

Within a sharded cluster, you enable sharding on a per-database basis. After enabling sharding for a database, you choose which collections to shard. For each sharded collection, you specify a *shard key*.

The shard key determines the distribution of the collection's *documents* among the cluster's *shards*. The shard key is a *field* that exists in every document in the collection. MongoDB distributes documents according to ranges of values in the shard key. A given shard holds documents for which the shard key falls within a specific range of values. Shard keys, like *indexes*, can be either a single field or multiple fields.

Within a shard, MongoDB further partitions documents into *chunks*. Each chunk represents a smaller range of values within the shard's range. When a chunk grows beyond the *chunk size* (page 379), MongoDB *splits* the chunk into smaller chunks, always based on ranges in the shard key.

32.1.2 Shard Key Selection

Choosing the correct shard key can have a great impact on the performance, capability, and functioning of your database and cluster. Appropriate shard key choice depends on the schema of your data and the way that your application queries and writes data to the database.

The ideal shard key:

- is easily divisible which makes it easy for MongoDB to distribute content among the shards. Shard keys that have a limited number of possible values are not ideal as they can result in some chunks that are "unsplitable." See the *Cardinality* (page 375) section for more information.
- will distribute write operations among the cluster, to prevent any single shard from becoming a bottleneck. Shard keys that have a high correlation with insert time are poor choices for this reason; however, shard keys that have higher "randomness" satisfy this requirement better. See the *Write Scaling* (page 375) section for additional background.
- will make it possible for the `mongos` (page 905) to return most query operations directly from a single *specific* `mongod` (page 897) instance. Your shard key should be the primary field used by your queries, and fields with a high degree of "randomness" are poor choices for this reason. See the *Query Isolation* (page 376) section for specific examples.

The challenge when selecting a shard key is that there is not always an obvious choice. Often, an existing field in your collection may not be the optimal key. In those situations, computing a special purpose shard key into an additional field or using a compound shard key may help produce one that is more ideal.

32.1.3 Shard Balancing

Balancing is the process MongoDB uses to redistribute data within a *sharded cluster*. When a *shard* has too many *chunks* when compared to other shards, MongoDB automatically balances the shards. MongoDB balances the shards without intervention from the application layer.

The balancing process attempts to minimize the impact that balancing can have on the cluster, by:

- Moving only one chunk at a time.
- Initiating a balancing round **only** when the difference in the number of chunks between the shard with the greatest number and the shard with the lowest exceeds the *migration threshold* (page 378).

You may disable the balancer on a temporary basis for maintenance and limit the window during which it runs to prevent the balancing process from impacting production traffic.

See Also:

Manage Sharded Cluster Balancer (page 398) and *Sharded Cluster Internals and Behaviors* (page 374).

Note: The balancing procedure for *sharded clusters* is entirely transparent to the user and application layer. This documentation is only included for your edification and possible troubleshooting purposes.

32.1.4 When to Use Sharding

While sharding is a powerful and compelling feature, it comes with significant *Infrastructure Requirements for Sharded Clusters* (page 367) and some limited complexity costs. As a result, use sharding only as necessary, and when indicated by actual operational requirements. Consider the following overview of indications it may be time to consider sharding.

You should consider deploying a *sharded cluster*, if:

- your data set approaches or exceeds the storage capacity of a single node in your system.
- the size of your system's active *working set will soon* exceed the capacity of the *maximum* amount of RAM for your system.
- your system has a large amount of write activity, a single MongoDB instance cannot write data fast enough to meet demand, and all other approaches have not reduced contention.

If these attributes are not present in your system, sharding will only add additional complexity to your system without providing much benefit. When designing your data model, if you will eventually need a sharded cluster, consider which collections you will want to shard and the corresponding shard keys.

Warning: It takes time and resources to deploy sharding, and if your system has *already* reached or exceeded its capacity, you will have a difficult time deploying sharding without impacting your application.
As a result, if you think you will need to partition your database in the future, **do not** wait until your system is overcapacity to enable sharding.

32.1.5 Infrastructure Requirements for Sharded Clusters

A *sharded cluster* has the following components:

- Three *config servers*.

  These special `mongod` (page 897) instances store the metadata for the cluster. The `mongos` (page 905) instances cache this data and use it to determine which *shard* is responsible for which *chunk*.

  For development and testing purposes you may deploy a cluster with a single configuration server process, but always use exactly three config servers for redundancy and safety in production.

- Two or more shards. Each shard consists of one or more `mongod` (page 897) instances that store the data for the shard.

  These "normal" `mongod` (page 897) instances hold all of the actual data for the cluster.

  Typically each shard is a *replica sets*. Each replica set consists of multiple `mongod` (page 897) instances. The members of the replica set provide redundancy and high available for the data in each shard.

  Warning: MongoDB enables data *partitioning*, or sharding, on a *per collection* basis. You *must* access all data in a sharded cluster via the `mongos` (page 905) instances as below. If you connect directly to a `mongod` (page 897) in a sharded cluster you will see its fraction of the cluster's data. The data on any given shard may be somewhat random: MongoDB provides no guarantee that any two contiguous chunks will reside on a single shard.

- One or more `mongos` (page 905) instances.

  These instance direct queries from the application layer to the shards that hold the data. The `mongos` (page 905) instances have no persistent state or data files and only cache metadata in RAM from the config servers.

  Note: In most situations `mongos` (page 905) instances use minimal resources, and you can run them on your application servers without impacting application performance. However, if you use the *aggregation framework* some processing may occur on the `mongos` (page 905) instances, causing that `mongos` (page 905) to require more system resources.

32.1.6 Data Quantity Requirements for Sharded Clusters

Your cluster must manage a significant quantity of data for sharding to have an effect on your collection. The default *chunk* size is 64 megabytes, and the *balancer* (page 366) will not begin moving data until the imbalance of chunks in the cluster exceeds the *migration threshold* (page 378).

Practically, this means that unless your cluster has many hundreds of megabytes of data, chunks will remain on a single shard.

While there are some exceptional situations where you may need to shard a small collection of data, most of the time the additional complexity added by sharding the small collection is not worth the additional complexity and overhead unless you need additional concurrency or capacity for some reason. If you have a small data set, usually a properly configured single MongoDB instance or replica set will be more than sufficient for your persistence layer needs.

Chunk size is `user configurable` (page 907). However, the default value is of 64 megabytes is ideal for most deployments. See the *Chunk Size* (page 379) section in the *Sharded Cluster Internals and Behaviors* (page 374) document for more information.

32.2 Sharded Cluster Administration

Sharding occurs within a *sharded cluster*. A sharded cluster consists of the following components:

- *Shards* (page 368). Each shard is a separate `mongod` (page 897) instance or *replica set* that holds a portion of the database collections.
- *Config servers* (page 368). Each config server is a `mongod` (page 897) instance that holds metadata about the cluster. The metadata maps *chunks* to shards.
- *mongos instances* (page 369). The `mongos` (page 905) instances route the reads and writes to the shards.

See Also:

- For specific configurations, see *Sharded Cluster Architectures* (page 372).
- To set up sharded clusters, see *Deploy a Sharded Cluster* (page 383).

32.2.1 Shards

A shard is a container that holds a subset of a collection's data. Each shard is either a single `mongod` (page 897) instance or a *replica set*. In production, all shards should be replica sets.

Applications do not access the shards directly. Instead, the *mongos instances* (page 369) routes reads and writes from applications to the shards.

32.2.2 Config Servers

Config servers maintain the shard metadata in a config database. The *config database* stores the relationship between *chunks* and where they reside within a *sharded cluster*. Without a config database, the `mongos` (page 905) instances would be unable to route queries or write operations within the cluster.

Config servers *do not* run as replica sets. Instead, a *cluster* operates with a group of *three* config servers that use a two-phase commit process that ensures immediate consistency and reliability.

For testing purposes you may deploy a cluster with a single config server, but this is not recommended for production.

> **Warning:** If your cluster has a single config server, this `mongod` (page 897) is a single point of failure. If the instance is inaccessible the cluster is not accessible. If you cannot recover the data on a config server, the cluster will be inoperable.
> **Always** use three config servers for production deployments.

The actual load on configuration servers is small because each `mongos` (page 905) instance maintains a cached copy of the configuration database. MongoDB only writes data to the config server to:

- create splits in existing chunks, which happens as data in existing chunks exceeds the maximum chunk size.

- migrate a chunk between shards.

Additionally, all config servers must be available on initial setup of a sharded cluster, each `mongos` (page 905) instance must be able to write to the `config.version` collection.

If one or two configuration instances become unavailable, the cluster's metadata becomes *read only*. It is still possible to read and write data from the shards, but no chunk migrations or splits will occur until all three servers are accessible. At the same time, config server data is only read in the following situations:

- A new `mongos` (page 905) starts for the first time, or an existing `mongos` (page 905) restarts.
- After a chunk migration, the `mongos` (page 905) instances update themselves with the new cluster metadata.

If all three config servers are inaccessible, you can continue to use the cluster as long as you don't restart the `mongos` (page 905) instances until after config servers are accessible again. If you restart the `mongos` (page 905) instances and there are no accessible config servers, the `mongos` (page 905) would be unable to direct queries or write operations to the cluster.

Because the configuration data is small relative to the amount of data stored in a cluster, the amount of activity is relatively low, and 100% up time is not required for a functioning sharded cluster. As a result, backing up the config servers is not difficult. Backups of config servers are critical as clusters become totally inoperable when you lose all configuration instances and data. Precautions to ensure that the config servers remain available and intact are critical.

Note: Configuration servers store metadata for a single sharded cluster. You must have a separate configuration server or servers for each cluster you administer.

32.2.3 Sharded Cluster Operations and `mongos` Instances

The `mongos` (page 905) program provides a single unified interface to a sharded cluster for applications using MongoDB. Except for the selection of a *shard key*, application developers and administrators need not consider any of the *internal details of sharding* (page 374).

`mongos` (page 905) caches data from the *config server* (page 368), and uses this to route operations from applications and clients to the `mongod` (page 897) instances. `mongos` (page 905) have no *persistent* state and consume minimal system resources.

The most common practice is to run `mongos` (page 905) instances on the same systems as your application servers, but you can maintain `mongos` (page 905) instances on the shards or on other dedicated resources.

Note: Changed in version 2.1. Some aggregation operations using the `aggregate` (page 740) command (i.e. `db.collection.aggregate()` (page 815),) will cause `mongos` (page 905) instances to require more CPU resources than in previous versions. This modified performance profile may dictate alternate architecture decisions if you use the *aggregation framework* extensively in a sharded environment.

Automatic Operation and Query Routing with `mongos`

`mongos` (page 905) uses information from *config servers* (page 368) to route operations to the cluster as efficiently as possible. In general, operations in a sharded environment are either:

1. Targeted at a single shard or a limited group of shards based on the shard key.
2. Broadcast to all shards in the cluster that hold documents in a collection.

When possible you should design your operations to be as targeted as possible. Operations have the following targeting characteristics:

- Query operations broadcast to all shards [1] **unless** the mongos (page 905) can determine which shard or shard stores this data.

  For queries that include the shard key, mongos (page 905) can target the query at a specific shard or set of shards, if the portion of the shard key included in the query is a *prefix* of the shard key. For example, if the shard key is:

  ```
  { a: 1, b: 1, c: 1 }
  ```

  The mongos (page 905) program *can* route queries that include the full shard key or either of the following shard key prefixes at a specific shard or set of shards:

  ```
  { a: 1 }
  { a: 1, b: 1 }
  ```

  Depending on the distribution of data in the cluster and the selectivity of the query, mongos (page 905) may still have to contact multiple shards [2] to fulfill these queries.

- All insert() (page 830) operations target to one shard.
- All single update() (page 842) operations target to one shard. This includes *upsert* operations.
- The mongos (page 905) broadcasts multi-update operations to every shard.
- The mongos (page 905) broadcasts remove() (page 838) operations to every shard unless the operation specifies the shard key in full.

While some operations must broadcast to all shards, you can improve performance by using as many targeted operations as possible by ensuring that your operations include the shard key.

Sharded Query Response Process

To route a query to a *cluster*, mongos (page 905) uses the following process:

1. Determine the list of *shards* that must receive the query.

   In some cases, when the *shard key* or a prefix of the shard key is a part of the query, the mongos (page 905) can route the query to a subset of the shards. Otherwise, the mongos (page 905) must direct the query to *all* shards that hold documents for that collection.

   Example

   Given the following shard key:

   ```
   { zipcode: 1, u_id: 1, c_date: 1 }
   ```

   Depending on the distribution of chunks in the cluster, the mongos (page 905) may be able to target the query at a subset of shards, if the query contains the following fields:

   ```
   { zipcode: 1 }
   { zipcode: 1, u_id: 1 }
   { zipcode: 1, u_id: 1, c_date: 1 }
   ```

   ---

2. Establish a cursor on all targeted shards.

   When the first batch of results returns from the cursors:

[1] If a shard does not store chunks from a given collection, queries for documents in that collection are not broadcast to that shard.
[2] mongos (page 905) will route some queries, even some that include the shard key, to all shards, if needed.

(a) For query with sorted results (i.e. using `cursor.sort()` (page 813)) the `mongos` (page 905) instance performs a merge sort of all queries.

(b) For a query with unsorted results, the `mongos` (page 905) instance returns a result cursor that "round robins" results from all cursors on the shards. Changed in version 2.0.5: Before 2.0.5, the `mongos` (page 905) exhausted each cursor, one by one.

32.2.4 Sharded Cluster Security Considerations

MongoDB controls access to *sharded clusters* with key files that store authentication credentials. The components of sharded clusters use the secret stored in the key files when authenticating to each other. Create key files and then point your `mongos` (page 905) and `mongod` (page 897) instances to the files, as described later in this section.

Beyond the `auth` (page 947) mechanisms described in this section, always run your sharded clusters in trusted networking environments that limit access to the cluster with network rules. Your networking environments should enforce restrictions that ensure only known traffic reaches your `mongos` (page 905) and `mongod` (page 897) instances.

This section describes authentication specific to sharded clusters. For information on authentication across MongoDB, see *Authentication* (page 90).

Access Control Privileges in Sharded Clusters

In sharded clusters, MongoDB provides separate administrative privileges for the sharded cluster and for each shard. Beyond these administration privileges, privileges for sharded cluster deployments are functionally the same as any other MongoDB deployment. See, *Authentication* (page 90) for more information.

For sharded clusters, MongoDB provides these separate administrative privileges:

- Administrative privileges for the sharded cluster. These privileges provide read-and-write access to the config servers' '*admin*. These users can run all administrative commands. Administrative privileges also give the user read-and-write access to all the cluster's databases.

  The credentials for administrative privileges on the cluster reside on the config servers. To receive admin access to the cluster, you must authenticate a session while connected to a `mongos` (page 905) instance using the admin database.

- Administrative privileges for the `mongod` (page 897) instance, or *replica set*, that provides each individual shard. Each shard has its own admin database that stores administrative credentials and access for that shard only. These credentials are *completely* distinct from the cluster-wide administrative credentials.

  As with all `mongod` (page 897) instances, MongoDB provides two types of administrative privileges for a shard:

  – Normal administrative privileges, which provide read-and-write access to the admin database and access to all administrative commands, and which provide read-and-write access to all other databases on that shard.

  – Read-only administrative privileges, which provide read-only access to the admin database and to all other databases on that shard.

Also, as with all `mongod` (page 897) instances, a MongoDB sharded cluster provides the following non-administrative user privileges:

- Normal privileges, which provide read-and-write access to a specific database. Users with normal privilege can add users to the database.
- Read-only privileges, which provide read-only access to a specific database.

For more information on privileges, see *Authentication* (page 90).

Enable Authentication in a Sharded Cluster

New in version 2.0: Support for authentication with sharded clusters. To control access to a sharded cluster, create key files and then set the `keyFile` (page 947) option on *all* components of the sharded cluster, including all `mongos` (page 905) instances, all config server `mongod` (page 897) instances, and all shard `mongod` (page 897) instances. The content of the key file is arbitrary but must be the same on all cluster members.

To enable authentication, do the following:

1. Generate a key file to store authentication information, as described in the *Generate a Key File* (page 105) section.
2. On each component in the sharded cluster, enable authentication by doing one of the following:
   - In the configuration file, set the `keyFile` (page 947) option to the key file's path and then start the component, as in the following example:

     ```
     keyFile = /srv/mongodb/keyfile
     ```

   - When starting the component, set `--keyFile` (page 906) option, which is an option for both `mongos` (page 905) instances and `mongod` (page 897) instances. Set the `--keyFile` (page 906) to the key file's path.

   Note: The `keyFile` (page 947) setting implies `auth` (page 947), which means in most cases you do not need to set `auth` (page 947) explicitly.
3. Add the first administrative user and then add subsequent users. See *Add Users* (page 103).

Access a Sharded Cluster with Authentication

To access a sharded cluster as an authenticated admin user, see *Administrative Access in MongoDB* (page 104).

To access a sharded cluster as an authenticated, non-admin user, see either of the following:

- `authenticate` (page 741)
- `db.auth()` (page 814)

To terminate an authenticated session, see the `logout` (page 775) command.

32.3 Sharded Cluster Architectures

This document describes the organization and design of *sharded cluster* deployments.

32.3.1 Restriction on the Use of the `localhost` Interface

Because all components of a *sharded cluster* must communicate with each other over the network, there are special restrictions regarding the use of localhost addresses:

If you use either "localhost" or "`127.0.0.1`" as the host identifier, then you must use "localhost" or "`127.0.0.1`" for *all* host settings for any MongoDB instances in the cluster. This applies to both the `host` argument to `addShard` (page 739) and the value to the *`mongos --configdb`* (page 906) run time option. If you mix localhost addresses with remote host address, MongoDB will produce errors.

32.3.2 Test Cluster Architecture

You can deploy a very minimal cluster for testing and development. These *non-production* clusters have the following components:

- One *config server* (page 368).
- At least one `mongod` (page 897) instance (either *replica sets* or as a standalone node.)
- One `mongos` (page 905) instance.

Warning: Use the test cluster architecture for testing and development only.

32.3.3 Production Cluster Architecture

In a production cluster, you must ensure that data is redundant and that your systems are highly available. To that end, a production-level cluster must have the following components:

- Three *config servers* (page 368), each residing on a discrete system.

  A single *sharded cluster* must have exclusive use of its *config servers* (page 368). If you have multiple shards, you will need to have a group of config servers for each cluster.

- Two or more *replica sets* to serve as *shards*. For information on replica sets, see *Replication* (page 277).
- Two or more `mongos` (page 905) instances. Typically, you deploy a single `mongos` (page 905) instance on each application server. Alternatively, you may deploy several `mongos` (page 905) nodes and let your application connect to these via a load balancer.

32.3.4 Sharded and Non-Sharded Data

Sharding operates on the collection level. You can shard multiple collections within a database, or have multiple databases with sharding enabled. [3] However, in production deployments some databases and collections will use sharding, while other databases and collections will only reside on a single database instance or replica set (i.e. a *shard*.)

Regardless of the data architecture of your *sharded cluster*, ensure that all queries and operations use the *mongos* router to access the data cluster. Use the `mongos` (page 905) even for operations that do not impact the sharded data.

Every database has a "primary" [4] shard that holds all un-sharded collections in that database. All collections that *are not* sharded reside on the primary for their database. Use the `movePrimary` (page 783) command to change the primary shard for a database. Use the `db.printShardingStatus()` (page 852) command or the `sh.status()` (page 871) to see an overview of the cluster, which contains information about the *chunk* and database distribution within the cluster.

Warning: The `movePrimary` (page 783) command can be expensive because it copies all non-sharded data to the new shard, during which that data will be unavailable for other operations.

When you deploy a new *sharded cluster*, the "first shard" becomes the primary for all databases before enabling sharding. Databases created subsequently, may reside on any shard in the cluster.

[3] As you configure sharding, you will use the `enableSharding` (page 755) command to enable sharding for a database. This simply makes it possible to use the `shardCollection` (page 794) command on a collection within that database.

[4] The term "primary" in the context of databases and sharding, has nothing to do with the term *primary* in the context of *replica sets*.

32.3.5 High Availability and MongoDB

A *production* (page 373) *cluster* has no single point of failure. This section introduces the availability concerns for MongoDB deployments and highlights potential failure scenarios and available resolutions:

- Application servers or `mongos` (page 905) instances become unavailable.

  If each application server has its own `mongos` (page 905) instance, other application servers can continue access the database. Furthermore, `mongos` (page 905) instances do not maintain persistent state, and they can restart and become unavailable without loosing any state or data. When a `mongos` (page 905) instance starts, it retrieves a copy of the *config database* and can begin routing queries.

- A single `mongod` (page 897) becomes unavailable in a shard.

  Replica sets (page 277) provide high availability for shards. If the unavailable `mongod` (page 897) is a *primary*, then the replica set will *elect* (page 280) a new primary. If the unavailable `mongod` (page 897) is a *secondary*, and it disconnects the primary and secondary will continue to hold all data. In a three member replica set, even if a single member of the set experiences catastrophic failure, two other members have full copies of the data. [5]

  Always investigate availability interruptions and failures. If a system is unrecoverable, replace it and create a new member of the replica set as soon as possible to replace the lost redundancy.

- All members of a replica set become unavailable.

  If all members of a replica set within a shard are unavailable, all data held in on that shard is unavailable. However, the data on all other shards will remain available, and it's possible to read and write data to the other shards. However, your application must be able to deal with partial results, and you should investigate the cause of the interruption and attempt to recover the shard as soon as possible.

- One or two *config database* become unavailable.

  Three distinct `mongod` (page 897) instances provide the *config database* using a special two-phase commits to maintain consistent state between these `mongod` (page 897) instances. Cluster operation will continue as normal but *chunk migration* (page 366) and the cluster can create no new *chunk splits* (page 392). Replace the config server as soon as possible. If all multiple config databases become unavailable, the cluster can become inoperable.

  Note: All config servers must be running and available when you first initiate a *sharded cluster*.

32.4 Sharded Cluster Internals and Behaviors

This document introduces lower level sharding concepts for users who are familiar with *sharding* generally and want to learn more about the internals. This document provides a more detailed understanding of your cluster's behavior. For higher level sharding concepts, see *Sharded Cluster Overview* (page 365). For complete documentation of sharded clusters see the *Sharding* (page 363) section of this manual.

32.4.1 Shard Keys

Shard keys are the field in a collection that MongoDB uses to distribute *documents* within a sharded cluster. See the *overview of shard keys* (page 365) for an introduction to these topics.

[5] If an unavailable secondary becomes available while it still has current oplog entries, it can catch up to the latest state of the set using the normal *replication process*, otherwise it must perform an *initial sync*.

Cardinality

Cardinality in the context of MongoDB, refers to the ability of the system to *partition* data into *chunks*. For example, consider a collection of data such as an "address book" that stores address records:

- Consider the use of a `state` field as a shard key:

  The state key's value holds the US state for a given address document. This field has a *low cardinality* as all documents that have the same value in the `state` field *must* reside on the same shard, even if a particular state's chunk exceeds the maximum chunk size.

  Since there are a limited number of possible values for the `state` field, MongoDB may distribute data unevenly among a small number of fixed chunks. This may have a number of effects:

  - If MongoDB cannot split a chunk because all of its documents have the same shard key, migrations involving these un-splitable chunks will take longer than other migrations, and it will be more difficult for your data to stay balanced.
  - If you have a fixed maximum number of chunks, you will never be able to use more than that number of shards for this collection.

- Consider the use of a `zipcode` field as a shard key:

  While this field has a large number of possible values, and thus has potentially higher cardinality, it's possible that a large number of users could have the same value for the shard key, which would make this chunk of users un-splitable.

  In these cases, cardinality depends on the data. If your address book stores records for a geographically distributed contact list (e.g. "Dry cleaning businesses in America,") then a value like zipcode would be sufficient. However, if your address book is more geographically concentrated (e.g "ice cream stores in Boston Massachusetts,") then you may have a much lower cardinality.

- Consider the use of a `phone-number` field as a shard key:

  Phone number has a *high cardinality,* because users will generally have a unique value for this field, MongoDB will be able to split as many chunks as needed.

While "high cardinality," is necessary for ensuring an even distribution of data, having a high cardinality does not guarantee sufficient *query isolation* (page 376) or appropriate *write scaling* (page 375). Please continue reading for more information on these topics.

Write Scaling

Some possible shard keys will allow your application to take advantage of the increased write capacity that the cluster can provide, while others do not. Consider the following example where you shard by the values of the default *_id* field, which is *ObjectID*.

`ObjectID` is computed upon document creation, that is a unique identifier for the object. However, the most significant bits of data in this value represent a time stamp, which means that they increment in a regular and predictable pattern. Even though this value has *high cardinality* (page 375), when using this, *any date, or other monotonically increasing number* as the shard key, all insert operations will be storing data into a single chunk, and therefore, a single shard. As a result, the write capacity of this shard will define the effective write capacity of the cluster.

A shard key that increases monotonically will not hinder performance if you have a very low insert rate, or if most of your write operations are `update()` (page 842) operations distributed through your entire data set. Generally, choose shard keys that have *both* high cardinality and will distribute write operations across the *entire cluster*.

Typically, a computed shard key that has some amount of "randomness," such as ones that include a cryptographic hash (i.e. MD5 or SHA1) of other content in the document, will allow the cluster to scale write operations. However,

random shard keys do not typically provide *query isolation* (page 376), which is another important characteristic of shard keys.

Querying

The `mongos` (page 905) provides an interface for applications to interact with sharded clusters that hides the complexity of *data partitioning*. A `mongos` (page 905) receives queries from applications, and uses metadata from the *config server* (page 368), to route queries to the `mongod` (page 897) instances with the appropriate data. While the `mongos` (page 905) succeeds in making all querying operational in sharded environments, the *shard key* you select can have a profound affect on query performance.

See Also:

The *mongos and Sharding* (page 369) and *config server* (page 368) sections for a more general overview of querying in sharded environments.

Query Isolation

The fastest queries in a sharded environment are those that `mongos` (page 905) will route to a single shard, using the *shard key* and the cluster meta data from the *config server* (page 368). For queries that don't include the shard key, `mongos` (page 905) must query all shards, wait for their response and then return the result to the application. These "scatter/gather" queries can be long running operations.

If your query includes the first component of a compound shard key [6], the `mongos` (page 905) can route the query directly to a single shard, or a small number of shards, which provides better performance. Even if you query values of the shard key reside in different chunks, the `mongos` (page 905) will route queries directly to specific shards.

To select a shard key for a collection:

- determine the most commonly included fields in queries for a given application
- find which of these operations are most performance dependent.

If this field has low cardinality (i.e not sufficiently selective) you should add a second field to the shard key making a compound shard key. The data may become more splitable with a compound shard key.

See Also:

Sharded Cluster Operations and mongos Instances (page 369) for more information on query operations in the context of sharded clusters. Specifically the *Automatic Operation and Query Routing with mongos* (page 369) sub-section outlines the procedure that `mongos` (page 905) uses to route read operations to the shards.

Sorting

In sharded systems, the `mongos` (page 905) performs a merge-sort of all sorted query results from the shards. See the *sharded query routing* (page 369) and *Use Indexes to Sort Query Results* (page 259) sections for more information.

Operations and Reliability

The most important consideration when choosing a *shard key* are:

- to ensure that MongoDB will be able to distribute data evenly among shards, and

[6] In many ways, you can think of the shard key a cluster-wide unique index. However, be aware that sharded systems cannot enforce cluster-wide unique indexes *unless* the unique field is in the shard key. Consider the *Indexing Overview* (page 241) page for more information on indexes and compound indexes.

- to scale writes across the cluster, and
- to ensure that `mongos` (page 905) can isolate most queries to a specific `mongod` (page 897).

Furthermore:

- Each shard should be a *replica set*, if a specific `mongod` (page 897) instance fails, the replica set members will elect another to be *primary* and continue operation. However, if an entire shard is unreachable or fails for some reason, that data will be unavailable.
- If the shard key allows the `mongos` (page 905) to isolate most operations to a single shard, then the failure of a single shard will only render *some* data unavailable.
- If your shard key distributes data required for every operation throughout the cluster, then the failure of the entire shard will render the entire cluster unavailable.

In essence, this concern for reliability simply underscores the importance of choosing a shard key that isolates query operations to a single shard.

Choosing a Shard Key

It is unlikely that any single, naturally occurring key in your collection will satisfy all requirements of a good shard key. There are three options:

1. Compute a more ideal shard key in your application layer, and store this in all of your documents, potentially in the `_id` field.
2. Use a compound shard key, that uses two or three values from all documents that provide the right mix of cardinality with scalable write operations and query isolation.
3. Determine that the impact of using a less than ideal shard key, is insignificant in your use case given:
   - limited write volume,
   - expected data size, or
   - query patterns and demands.

From a decision making stand point, begin by finding the field that will provide the required *query isolation* (page 376), ensure that *writes will scale across the cluster* (page 376), and then add an additional field to provide additional *cardinality* (page 375) if your primary key does not have sufficient split-ability.

Shard Key Indexes

All sharded collections **must** have an index that starts with the *shard key*. If you shard a collection that does not yet contain documents and *without* such an index, the `shardCollection` (page 794) command will create an index on the shard key. If the collection already contains documents, you must create an appropriate index before using `shardCollection` (page 794). Changed in version 2.2: The index on the shard key no longer needs to be identical to the shard key. This index can be an index of the shard key itself as before, or a *compound index* where the shard key is the prefix of the index. This index *cannot* be a multikey index. If you have a collection named `people`, sharded using the field `{ zipcode: 1 }`, and you want to replace this with an index on the field `{ zipcode: 1, username: 1 }`, then:

1. Create an index on `{ zipcode: 1, username: 1 }`:

   ```
   db.people.ensureIndex( { zipcode: 1, username: 1 } );
   ```

2. When MongoDB finishes building the index, you can safely drop existing index on `{ zipcode: 1 }`:

```
db.people.dropIndex( { zipcode: 1 } );
```

Warning: The index on the shard key **cannot** be a multikey index.
As above, an index on `{ zipcode: 1, username: 1 }` can only replace an index on `zipcode` if there are no array values for the `username` field.
If you drop the last appropriate index for the shard key, recover by recreating a index on just the shard key.

32.4.2 Cluster Balancer

The *balancer* (page 366) sub-process is responsible for redistributing chunks evenly among the shards and ensuring that each member of the cluster is responsible for the same volume of data. This section contains complete documentation of the balancer process and operations. For a higher level introduction see the *Shard Balancing* (page 366) section.

Balancing Internals

A balancing round originates from an arbitrary `mongos` (page 905) instance from one of the cluster's `mongos` (page 905) instances. When a balancer process is active, the responsible `mongos` (page 905) acquires a "lock" by modifying a document in the `lock` collection in the *Config Database Contents* (page 1013).

By default, the balancer process is always running. When the number of chunks in a collection is unevenly distributed among the shards, the balancer begins migrating *chunks* from shards with more chunks to shards with a fewer number of chunks. The balancer will continue migrating chunks, one at a time, until the data is evenly distributed among the shards.

While these automatic chunk migrations are crucial for distributing data, they carry some overhead in terms of bandwidth and workload, both of which can impact database performance. As a result, MongoDB attempts to minimize the effect of balancing by only migrating chunks when the distribution of chunks passes the *migration thresholds* (page 378).

The migration process ensures consistency and maximizes availability of chunks during balancing: when MongoDB begins migrating a chunk, the database begins copying the data to the new server and tracks incoming write operations. After migrating chunks, the "from" `mongod` (page 897) sends all new writes to the "receiving" server. Finally, `mongos` (page 905) updates the chunk record in the *config database* to reflect the new location of the chunk.

Note: Changed in version 2.0: Before MongoDB version 2.0, large differences in timekeeping (i.e. clock skew) between `mongos` (page 905) instances could lead to failed distributed locks, which carries the possibility of data loss, particularly with skews larger than 5 minutes. Always use the network time protocol (NTP) by running `ntpd` on your servers to minimize clock skew.

Migration Thresholds

Changed in version 2.2: The following thresholds appear first in 2.2; prior to this release, balancing would only commence if the shard with the most chunks had 8 more chunks than the shard with the least number of chunks. In order to minimize the impact of balancing on the cluster, the *balancer* will not begin balancing until the distribution of chunks has reached certain thresholds. These thresholds apply to the difference in number of *chunks* between the shard with the greatest number of chunks and the shard with the least number of chunks. The balancer has the following thresholds:

Number of Chunks	Migration Threshold
Less than 20	2
21-80	4
Greater than 80	8

Once a balancing round starts, the balancer will not stop until the difference between the number of chunks on any two shards is *less than two.*

Note: You can restrict the balancer so that it only operates between specific start and end times. See *Schedule the Balancing Window* (page 399) for more information.

The specification of the balancing window is relative to the local time zone of all individual `mongos` (page 905) instances in the sharded cluster.

Chunk Size

The default *chunk* size in MongoDB is 64 megabytes.

When chunks grow beyond the *specified chunk size* (page 379) a `mongos` (page 905) instance will split the chunk in half. This will eventually lead to migrations, when chunks become unevenly distributed among the cluster. The `mongos` (page 905) instances will initiate a round of migrations to redistribute data in the cluster.

Chunk size is arbitrary and must account for the following:

1. Small chunks lead to a more even distribution of data at the expense of more frequent migrations, which creates expense at the query routing (`mongos` (page 905)) layer.
2. Large chunks lead to fewer migrations, which is more efficient both from the networking perspective *and* in terms internal overhead at the query routing layer. Large chunks produce these efficiencies at the expense of a potentially more uneven distribution of data.

For many deployments it makes sense to avoid frequent and potentially spurious migrations at the expense of a slightly less evenly distributed data set, but this value is *configurable* (page 394). Be aware of the following limitations when modifying chunk size:

- Automatic splitting only occurs when inserting *documents* or updating existing documents; if you lower the chunk size it may take time for all chunks to split to the new size.
- Splits cannot be "undone:" if you increase the chunk size, existing chunks must grow through insertion or updates until they reach the new size.

Note: Chunk ranges are inclusive of the lower boundary and exclusive of the upper boundary.

Shard Size

By default, MongoDB will attempt to fill all available disk space with data on every shard as the data set grows. Monitor disk utilization in addition to other performance metrics, to ensure that the cluster always has capacity to accommodate additional data.

You can also configure a "maximum size" for any shard when you add the shard using the `maxSize` parameter of the `addShard` (page 739) command. This will prevent the *balancer* from migrating chunks to the shard when the value of `mapped` (page 970) exceeds the `maxSize` setting.

See Also:

Change the Maximum Storage Size for a Given Shard (page 397) and *Monitoring Database Systems* (page 55).

Chunk Migration

MongoDB migrates chunks in a *sharded cluster* to distribute data evenly among shards. Migrations may be either:

- Manual. In these migrations you must specify the chunk that you want to migrate and the destination shard. Only migrate chunks manually after initiating sharding, to distribute data during bulk inserts, or if the cluster becomes uneven. See *Migrating Chunks* (page 395) for more details.
- Automatic. The balancer process handles most migrations when distribution of chunks between shards becomes uneven. See *Migration Thresholds* (page 378) for more details.

All chunk migrations use the following procedure:

1. The balancer process sends the `moveChunk` (page 782) command to the source shard for the chunk. In this operation the balancer passes the name of the destination shard to the source shard.
2. The source initiates the move with an internal `moveChunk` (page 782) command with the destination shard.
3. The destination shard begins requesting documents in the chunk, and begins receiving these chunks.
4. After receiving the final document in the chunk, the destination shard initiates a synchronization process to ensure that all changes to the documents in the chunk on the source shard during the migration process exist on the destination shard.

   When fully synchronized, the destination shard connects to the *config database* and updates the chunk location in the cluster metadata. After completing this operation, once there are no open cursors on the chunk, the source shard starts deleting its copy of documents from the migrated chunk.

If enabled, the `_secondaryThrottle` setting causes the balancer to wait for replication to secondaries. For more information, see *Require Replication before Chunk Migration (Secondary Throttle)* (page 398).

Detect Connections to `mongos` Instances

If your application must detect if the MongoDB instance its connected to is `mongos` (page 905), use the `isMaster` (page 772) command. When a client connects to a `mongos` (page 905), `isMaster` (page 772) returns a document with a `msg` field that holds the string `isdbgrid`. For example:

```
{
   "ismaster" : true,
   "msg" : "isdbgrid",
   "maxBsonObjectSize" : 16777216,
   "ok" : 1
}
```

If the application is instead connected to a `mongod` (page 897), the returned document does not include the `isdbgrid` string.

32.4.3 Config Database

The `config` database contains information about your sharding configuration and stores the information in a set of collections used by sharding.

Important: Back up the `config` database before performing any maintenance on the config server.

To access the `config` database, issue the following command from the `mongo` (page 908) shell:

```
use config
```

In general, you should *never* manipulate the content of the config database directly. The `config` database contains the following collections:

- `changelog` (page 1013)
- `chunks` (page 1015)
- `collections` (page 1015)
- `databases` (page 1016)
- `lockpings` (page 1016)
- `locks` (page 1016)
- `mongos` (page 1017)
- `settings` (page 1017)
- `shards` (page 1017)
- `version` (page 1018)

See *Config Database Contents* (page 1013) for full documentation of these collections and their role in sharded clusters.

32.4.4 Sharding GridFS Stores

When sharding a *GridFS* store, consider the following:

- Most deployments will not need to shard the `files` collection. The `files` collection is typically small, and only contains metadata. None of the required keys for GridFS lend themselves to an even distribution in a sharded situation. If you *must* shard the `files` collection, use the `_id` field possibly in combination with an application field

  Leaving `files` unsharded means that all the file metadata documents live on one shard. For production GridFS stores you *must* store the `files` collection on a replica set.

- To shard the `chunks` collection by `{ files_id : 1 , n : 1 }`, issue commands similar to the following:

  ```
  db.fs.chunks.ensureIndex( { files_id : 1 , n : 1 } )

  db.runCommand( { shardCollection : "test.fs.chunks" , key : { files_id : 1 , n : 1 } } )
  ```

  You may also want shard using just the `file_id` field, as in the following operation:

  ```
  db.runCommand( { shardCollection : "test.fs.chunks" , key : {  files_id : 1 } } )
  ```

  Note: Changed in version 2.2. Before 2.2, you had to create an additional index on `files_id` to shard using *only* this field.

  The default `files_id` value is an *ObjectId*, as a result the values of `files_id` are always ascending, and applications will insert all new GridFS data to a single chunk and shard. If your write load is too high for a single server to handle, consider a different shard key or use a different value for different value for `_id` in the `files` collection.

CHAPTER 33

Sharded Cluster Tutorials and Procedures

The documents listed in this section address common sharded cluster operational practices in greater detail.

33.1 Getting Started With Sharded Clusters

33.1.1 Deploy a Sharded Cluster

The topics on this page present an ordered sequence of the tasks required to set up a *sharded cluster*. Before deploying a sharded cluster for the first time, consider the *Sharded Cluster Overview* (page 365) and *Sharded Cluster Architectures* (page 372) documents.

To set up a sharded cluster, complete the following sequence of tasks in the order defined below:

1. *Start the Config Server Database Instances* (page 383)
2. *Start the mongos Instances* (page 384)
3. *Add Shards to the Cluster* (page 384)
4. *Enable Sharding for a Database* (page 385)
5. *Enable Sharding for a Collection* (page 386)

Warning: Sharding and "localhost" Addresses
If you use either "localhost" or `127.0.0.1` as the hostname portion of any host identifier, for example as the `host` argument to `addShard` (page 739) or the value to the `--configdb` (page 906) run time option, then you must use "localhost" or `127.0.0.1` for *all* host settings for any MongoDB instances in the cluster. If you mix localhost addresses and remote host address, MongoDB will error.

Start the Config Server Database Instances

The config server processes are `mongod` (page 897) instances that store the cluster's metadata. You designate a `mongod` (page 897) as a config server using the `--configsvr` (page 904) option. Each config server stores a complete copy of the cluster's metadata.

In production deployments, you must deploy exactly three config server instances, each running on different servers to assure good uptime and data safety. In test environments, you can run all three instances on a single server.

Config server instances receive relatively little traffic and demand only a small portion of system resources. Therefore, you can run an instance on a system that runs other cluster components.

1. Create data directories for each of the three config server instances. By default, a config server stores its data files in the */data/configdb* directory. You can choose a different location. To create a data directory, issue a command similar to the following:

   ```
   mkdir /data/configdb
   ```

2. Start the three config server instances. Start each by issuing a command using the following syntax:

   ```
   mongod --configsvr --dbpath <path> --port <port>
   ```

   The default port for config servers is `27019`. You can specify a different port. The following example starts a config server using the default port and default data directory:

   ```
   mongod --configsvr --dbpath /data/configdb --port 27019
   ```

   For additional command options, see *mongod* (page 897) or *Configuration File Options* (page 944).

   Note: All config servers must be running and available when you first initiate a *sharded cluster*.

Start the `mongos` Instances

The `mongos` (page 905) instances are lightweight and do not require data directories. You can run a `mongos` (page 905) instance on a system that runs other cluster components, such as on an application server or a server running a `mongod` (page 897) process. By default, a `mongos` (page 905) instance runs on port `27017`.

When you start the `mongos` (page 905) instance, specify the hostnames of the three config servers, either in the configuration file or as command line parameters. For operational flexibility, use DNS names for the config servers rather than explicit IP addresses. If you're not using resolvable hostname, you cannot change the config server names or IP addresses without a restarting *every* `mongos` (page 905) and `mongod` (page 897) instance.

To start a `mongos` (page 905) instance, issue a command using the following syntax:

```
mongos --configdb <config server hostnames>
```

For example, to start a `mongos` (page 905) that connects to config server instance running on the following hosts and on the default ports:

- `cfg0.example.net`
- `cfg1.example.net`
- `cfg2.example.net`

You would issue the following command:

```
mongos --configdb cfg0.example.net:27019,cfg1.example.net:27019,cfg2.example.net:27019
```

Add Shards to the Cluster

A *shard* can be a standalone `mongod` (page 897) or or a *replica set*. In a production environment, each shard should be a replica set.

1. From a mongo (page 908) shell, connect to the mongos (page 905) instance. Issue a command using the following syntax:

   ```
   mongo --host <hostname of machine running mongos> --port <port mongos listens on>
   ```

   For example, if a mongos (page 905) is accessible at mongos0.example.net on port 27017, issue the following command:

   ```
   mongo --host mongos0.example.net --port 27017
   ```

2. Add each shard to the cluster using the sh.addShard() (page 864) method, as shown in the examples below. Issue sh.addShard() (page 864) separately for each shard. If the shard is a replica set, specify the name of the replica set and specify a member of the set. In production deployments, all shards should be replica sets.

   Optional

   You can instead use the addShard (page 739) database command, which lets you specify a name and maximum size for the shard. If you do not specify these, MongoDB automatically assigns a name and maximum size. To use the database command, see addShard (page 739).

   The following are examples of adding a shard with sh.addShard() (page 864):

   - To add a shard for a replica set named rs1 with a member running on port 27017 on mongodb0.example.net, issue the following command:

     ```
     sh.addShard( "rs1/mongodb0.example.net:27017" )
     ```

     Changed in version 2.0.3. For MongoDB versions prior to 2.0.3, you must specify all members of the replica set. For example:

     ```
     sh.addShard( "rs1/mongodb0.example.net:27017,mongodb1.example.net:27017,mongodb2.example.net
     ```

   - To add a shard for a standalone mongod (page 897) on port 27017 of mongodb0.example.net, issue the following command:

     ```
     sh.addShard( "mongodb0.example.net:27017" )
     ```

   Note: It might take some time for *chunks* to migrate to the new shard.

Enable Sharding for a Database

Before you can shard a collection, you must enable sharding for the collection's database. Enabling sharding for a database does not redistribute data but make it possible to shard the collections in that database.

Once you enable sharding for a database, MongoDB assigns a *primary shard* for that database where MongoDB stores all data before sharding begins.

1. From a mongo (page 908) shell, connect to the mongos (page 905) instance. Issue a command using the following syntax:

   ```
   mongo --host <hostname of machine running mongos> --port <port mongos listens on>
   ```

2. Issue the sh.enableSharding() (page 867) method, specifying the name of the database for which to enable sharding. Use the following syntax:

```
sh.enableSharding("<database>")
```

Optionally, you can enable sharding for a database using the `enableSharding` (page 755) command, which uses the following syntax:

```
db.runCommand( { enableSharding: <database> } )
```

Enable Sharding for a Collection

You enable sharding on a per-collection basis.

1. Determine what you will use for the *shard key*. Your selection of the shard key affects the efficiency of sharding. See the selection considerations listed in the *Shard Key Selection* (page 365).
2. Enable sharding for a collection by issuing the `sh.shardCollection()` (page 870) method in the `mongo` (page 908) shell. The method uses the following syntax:

   ```
   sh.shardCollection("<database>.<collection>", shard-key-pattern)
   ```

   Replace the `<database>.<collection>` string with the full namespace of your database, which consists of the name of your database, a dot (e.g. `.`), and the full name of the collection. The `shard-key-pattern` represents your shard key, which you specify in the same form as you would an `index` (page 819) key pattern.

Example

The following sequence of commands shards four collections:

```
sh.shardCollection("records.people", { "zipcode": 1, "name": 1 } )
sh.shardCollection("people.addresses", { "state": 1, "_id": 1 } )
sh.shardCollection("assets.chairs", { "type": 1, "_id": 1 } )
sh.shardCollection("events.alerts", { "hashed_id": 1 } )
```

In order, these operations shard:

1. The `people` collection in the `records` database using the shard key `{ "zipcode": 1, "name": 1 }`.

   This shard key distributes documents by the value of the `zipcode` field. If a number of documents have the same value for this field, then that *chunk* will be *splitable* (page 375) by the values of the `name` field.

2. The `addresses` collection in the `people` database using the shard key `{ "state": 1, "_id": 1 }`.

   This shard key distributes documents by the value of the `state` field. If a number of documents have the same value for this field, then that *chunk* will be *splitable* (page 375) by the values of the `_id` field.

3. The `chairs` collection in the `assets` database using the shard key `{ "type": 1, "_id": 1 }`.

   This shard key distributes documents by the value of the `type` field. If a number of documents have the same value for this field, then that *chunk* will be *splitable* (page 375) by the values of the `_id` field.

4. The `alerts` collection in the `events` database using the shard key `{ "hashed_id": 1 }`.

   This shard key distributes documents by the value of the `hashed_id` field. Presumably this is a computed value that holds the hash of some value in your documents and is able to evenly distribute documents throughout your cluster.

33.1.2 Add Shards to a Cluster

You add shards to a *sharded cluster* after you create the cluster or anytime that you need to add capacity to the cluster. If you have not created a sharded cluster, see *Deploy a Sharded Cluster* (page 383).

When adding a shard to a cluster, you should always ensure that the cluster has enough capacity to support the migration without affecting legitimate production traffic.

In production environments, all shards should be *replica sets*.

Add a Shard to a Cluster

You interact with a sharded cluster by connecting to a `mongos` (page 905) instance.

1. From a `mongo` (page 908) shell, connect to the `mongos` (page 905) instance. Issue a command using the following syntax:

   ```
   mongo --host <hostname of machine running mongos> --port <port mongos listens on>
   ```

   For example, if a `mongos` (page 905) is accessible at `mongos0.example.net` on port `27017`, issue the following command:

   ```
   mongo --host mongos0.example.net --port 27017
   ```

2. Add each shard to the cluster using the `sh.addShard()` (page 864) method, as shown in the examples below. Issue `sh.addShard()` (page 864) separately for each shard. If the shard is a replica set, specify the name of the replica set and specify a member of the set. In production deployments, all shards should be replica sets.

   Optional

   You can instead use the `addShard` (page 739) database command, which lets you specify a name and maximum size for the shard. If you do not specify these, MongoDB automatically assigns a name and maximum size. To use the database command, see `addShard` (page 739).

   The following are examples of adding a shard with `sh.addShard()` (page 864):

   - To add a shard for a replica set named `rs1` with a member running on port `27017` on `mongodb0.example.net`, issue the following command:

     ```
     sh.addShard( "rs1/mongodb0.example.net:27017" )
     ```

     Changed in version 2.0.3. For MongoDB versions prior to 2.0.3, you must specify all members of the replica set. For example:

     ```
     sh.addShard( "rs1/mongodb0.example.net:27017,mongodb1.example.net:27017,mongodb2.example.net
     ```

   - To add a shard for a standalone `mongod` (page 897) on port `27017` of `mongodb0.example.net`, issue the following command:

     ```
     sh.addShard( "mongodb0.example.net:27017" )
     ```

   Note: It might take some time for *chunks* to migrate to the new shard.

33.1.3 View Cluster Configuration

List Databases with Sharding Enabled

To list the databases that have sharding enabled, query the `databases` collection in the *Config Database Contents* (page 1013). A database has sharding enabled if the value of the `partitioned` field is `true`. Connect to a `mongos` (page 905) instance with a `mongo` (page 908) shell, and run the following operation to get a full list of databases with sharding enabled:

```
use config
db.databases.find( { "partitioned": true } )
```

Example

You can use the following sequence of commands when to return a list of all databases in the cluster:

```
use config
db.databases.find()
```

If this returns the following result set:

```
{ "_id" : "admin", "partitioned" : false, "primary" : "config" }
{ "_id" : "animals", "partitioned" : true, "primary" : "m0.example.net:30001" }
{ "_id" : "farms", "partitioned" : false, "primary" : "m1.example2.net:27017" }
```

Then sharding is only enabled for the `animals` database.

List Shards

To list the current set of configured shards, use the `listShards` (page 774) command, as follows:

```
use admin
db.runCommand( { listShards : 1 } )
```

View Cluster Details

To view cluster details, issue `db.printShardingStatus()` (page 852) or `sh.status()` (page 871). Both methods return the same output.

Example

In the following example output from `sh.status()` (page 871)

- `sharding version` displays the version number of the shard metadata.
- `shards` displays a list of the `mongod` (page 897) instances used as shards in the cluster.
- `databases` displays all databases in the cluster, including database that do not have sharding enabled.
- The `chunks` information for the `foo` database displays how many chunks are on each shard and displays the range of each chunk.

```
--- Sharding Status ---
  sharding version: { "_id" : 1, "version" : 3 }
  shards:
    {  "_id" : "shard0000",  "host" : "m0.example.net:30001" }
```

```
  {  "_id" : "shard0001",  "host" : "m3.example2.net:50000" }
databases:
  {  "_id" : "admin",  "partitioned" : false,  "primary" : "config" }
  {  "_id" : "animals",  "partitioned" : true,  "primary" : "shard0000" }
      foo.big chunks:
              shard0001    1
              shard0000    6
          { "a" : { $minKey : 1 } } -->> { "a" : "elephant" } on : shard0001 Timestamp(2000, 1) jur
          { "a" : "elephant" } -->> { "a" : "giraffe" } on : shard0000 Timestamp(1000, 1) jumbo
          { "a" : "giraffe" } -->> { "a" : "hippopotamus" } on : shard0000 Timestamp(2000, 2) jumbo
          { "a" : "hippopotamus" } -->> { "a" : "lion" } on : shard0000 Timestamp(2000, 3) jumbo
          { "a" : "lion" } -->> { "a" : "rhinoceros" } on : shard0000 Timestamp(1000, 3) jumbo
          { "a" : "rhinoceros" } -->> { "a" : "springbok" } on : shard0000 Timestamp(1000, 4)
          { "a" : "springbok" } -->> { "a" : { $maxKey : 1 } } on : shard0000 Timestamp(1000, 5)
      foo.large chunks:
              shard0001    1
              shard0000    5
          { "a" : { $minKey : 1 } } -->> { "a" : "hen" } on : shard0001 Timestamp(2000, 0)
          { "a" : "hen" } -->> { "a" : "horse" } on : shard0000 Timestamp(1000, 1) jumbo
          { "a" : "horse" } -->> { "a" : "owl" } on : shard0000 Timestamp(1000, 2) jumbo
          { "a" : "owl" } -->> { "a" : "rooster" } on : shard0000 Timestamp(1000, 3) jumbo
          { "a" : "rooster" } -->> { "a" : "sheep" } on : shard0000 Timestamp(1000, 4)
          { "a" : "sheep" } -->> { "a" : { $maxKey : 1 } } on : shard0000 Timestamp(1000, 5)
  {  "_id" : "test",  "partitioned" : false,  "primary" : "shard0000" }
```

33.2 Sharded Cluster Maintenance and Administration

33.2.1 Manage the Config Servers

Config servers (page 368) store all cluster metadata, most importantly, the mapping from *chunks* to *shards*. This section provides an overview of the basic procedures to migrate, replace, and maintain these servers.

This page includes the following:

- *Deploy Three Config Servers for Production Deployments* (page 389)
- *Migrate Config Servers with the Same Hostname* (page 390)
- *Migrate Config Servers with Different Hostnames* (page 390)
- *Replace a Config Server* (page 391)
- *Backup Cluster Metadata* (page 391)

Deploy Three Config Servers for Production Deployments

For redundancy, all production *sharded clusters* should deploy three config servers processes on three different machines.

Do not use only a single config server for production deployments. Only use a single config server deployments for testing. You should upgrade to three config servers immediately if you are shifting to production. The following process shows how to convert a test deployment with only one config server to production deployment with three config servers.

1. Shut down all existing MongoDB processes in the cluster. This includes:

- all `mongod` (page 897) instances or *replica sets* that provide your shards.
- all `mongos` (page 905) instances in your cluster.

2. Copy the entire `dbpath` (page 947) file system tree from the existing config server to the two machines that will provide the additional config servers. These commands, issued on the system with the existing *Config Database Contents* (page 1013), `mongo-config0.example.net` may resemble the following:

```
rsync -az /data/configdb mongo-config1.example.net:/data/configdb
rsync -az /data/configdb mongo-config2.example.net:/data/configdb
```

3. Start all three config servers, using the same invocation that you used for the single config server.

```
mongod --configsvr
```

4. Restart all shard `mongod` (page 897) and `mongos` (page 905) processes.

Migrate Config Servers with the Same Hostname

Use this process when you need to migrate a config server to a new system but the new system will be accessible using the same host name.

1. Shut down the config server that you're moving.

   This will render all config data for your cluster *read only* (page 368).

2. Change the DNS entry that points to the system that provided the old config server, so that the *same* hostname points to the new system.

   How you do this depends on how you organize your DNS and hostname resolution services.

3. Move the entire `dbpath` (page 947) file system tree from the old config server to the new config server. This command, issued on the old config server system, may resemble the following:

```
rsync -az /data/configdb mongo-config0.example.net:/data/configdb
```

4. Start the config instance on the new system. The default invocation is:

```
mongod --configsvr
```

When you start the third config server, your cluster will become writable and it will be able to create new splits and migrate chunks as needed.

Migrate Config Servers with Different Hostnames

Use this process when you need to migrate a *Config Database Contents* (page 1013) to a new server and it *will not* be accessible via the same hostname. If possible, avoid changing the hostname so that you can use the *previous procedure* (page 390).

1. Disable the cluster balancer process temporarily. See *Disable the Balancer* (page 399) for more information.
2. Shut down the *config server* (page 368) you're moving.

   This will render all config data for your cluster "read only:"

```
rsync -az /data/configdb mongodb.config2.example.net:/data/configdb
```

3. Start the config instance on the new system. The default invocation is:

```
mongod --configsvr
```

4. Shut down all existing MongoDB processes. This includes:
   - all `mongod` (page 897) instances or *replica sets* that provide your shards.
   - the `mongod` (page 897) instances that provide your existing *config databases* (page 1013).
   - all `mongos` (page 905) instances in your cluster.
5. Restart all `mongod` (page 897) processes that provide the shard servers.
6. Update the `--configdb` (page 906) parameter (or `configdb` (page 954)) for all `mongos` (page 905) instances and restart all `mongos` (page 905) instances.
7. Re-enable the balancer to allow the cluster to resume normal balancing operations. See the *Disable the Balancer* (page 399) section for more information on managing the balancer process.

Replace a Config Server

Use this procedure only if you need to replace one of your config servers after it becomes inoperable (e.g. hardware failure.) This process assumes that the hostname of the instance will not change. If you must change the hostname of the instance, use the process for *migrating a config server to a different hostname* (page 390).

1. Disable the cluster balancer process temporarily. See *Disable the Balancer* (page 399) for more information.
2. Provision a new system, with the same hostname as the previous host.

   You will have to ensure that the new system has the same IP address and hostname as the system it's replacing *or* you will need to modify the DNS records and wait for them to propagate.
3. Shut down *one* (and only one) of the existing config servers. Copy all this host's `dbpath` (page 947) file system tree from the current system to the system that will provide the new config server. This command, issued on the system with the data files, may resemble the following:

   ```
   rsync -az /data/configdb mongodb.config2.example.net:/data/configdb
   ```
4. Restart the config server process that you used in the previous step to copy the data files to the new config server instance.
5. Start the new config server instance. The default invocation is:

   ```
   mongod --configsvr
   ```
6. Re-enable the balancer to allow the cluster to resume normal balancing operations. See the *Disable the Balancer* (page 399) section for more information on managing the balancer process.

Note: In the course of this procedure *never* remove a config server from the `configdb` (page 954) parameter on any of the `mongos` (page 905) instances. If you need to change the name of a config server, always make sure that all `mongos` (page 905) instances have three config servers specified in the `configdb` (page 954) setting at all times.

Backup Cluster Metadata

The cluster will remain operational [1] without one of the config database's `mongod` (page 897) instances, creating a backup of the cluster metadata from the config database is straight forward:

1. Disable the cluster balancer process temporarily. See *Disable the Balancer* (page 399) for more information.

[1] While one of the three config servers is unavailable, the cluster cannot split any chunks nor can it migrate chunks between shards. Your application will be able to write data to the cluster. The *Config Servers* (page 368) section of the documentation provides more information on this topic.

2. Shut down one of the *config databases*.
3. Create a full copy of the data files (i.e. the path specified by the `dbpath` (page 947) option for the config instance.)
4. Restart the original configuration server.
5. Re-enable the balancer to allow the cluster to resume normal balancing operations. See the *Disable the Balancer* (page 399) section for more information on managing the balancer process.

See Also:

Backup Strategies for MongoDB Systems (page 67).

33.2.2 Manage Chunks in a Sharded Cluster

This page describes various operations on *chunks* in *sharded clusters*. MongoDB automates most chunk management operations. However, these chunk management operations are accessible to administrators for use in some situations, typically surrounding initial setup, deployment, and data ingestion.

Split Chunks

Normally, MongoDB splits a *chunk* following inserts when a chunk exceeds the *chunk size* (page 379). The *balancer* may migrate recently split chunks to a new shard immediately if `mongos` (page 905) predicts future insertions will benefit from the move.

MongoDB treats all chunks the same, whether split manually or automatically by the system.

Warning: You cannot merge or combine chunks once you have split them.

You may want to split chunks manually if:

- you have a large amount of data in your cluster and very few *chunks*, as is the case after deploying a cluster using existing data.
- you expect to add a large amount of data that would initially reside in a single chunk or shard.

Example

You plan to insert a large amount of data with *shard key* values between `300` and `400`, *but* all values of your shard keys are between `250` and `500` are in a single chunk.

Warning: Be careful when splitting data in a sharded collection to create new chunks. When you shard a collection that has existing data, MongoDB automatically creates chunks to evenly distribute the collection. To split data effectively in a sharded cluster you must consider the number of documents in a chunk and the average document size to create a uniform chunk size. When chunks have irregular sizes, shards may have an equal number of chunks but have very different data sizes. Avoid creating splits that lead to a collection with differently sized chunks.

Use `sh.status()` (page 871) to determine the current chunks ranges across the cluster.

To split chunks manually, use the `split` (page 796) command with operators: `middle` and `find`. The equivalent shell helpers are `sh.splitAt()` (page 870) or `sh.splitFind()` (page 870).

Example

The following command will split the chunk that contains the value of `63109` for the `zipcode` field in the `people` collection of the `records` database:

```
sh.splitFind( "records.people", { "zipcode": 63109 } )
```

`sh.splitFind()` (page 870) will split the chunk that contains the *first* document returned that matches this query into two equally sized chunks. You must specify the full namespace (i.e. "`<database>.<collection>`") of the sharded collection to `sh.splitFind()` (page 870). The query in `sh.splitFind()` (page 870) need not contain the shard key, though it almost always makes sense to query for the shard key in this case, and including the shard key will expedite the operation.

Use `sh.splitAt()` (page 870) to split a chunk in two using the queried document as the partition point:

```
sh.splitAt( "records.people", { "zipcode": 63109 } )
```

However, the location of the document that this query finds with respect to the other documents in the chunk does not affect how the chunk splits.

Create Chunks (Pre-Splitting)

Pre-splitting the chunk ranges in an empty sharded collection, allows clients to insert data into an already-partitioned collection. In most situations a *sharded cluster* will create and distribute chunks automatically without user intervention. However, in a limited number of use profiles, MongoDB cannot create enough chunks or distribute data fast enough to support required throughput. For example, if:

- you must partition an existing data collection that resides on a single shard.
- you must ingest a large volume of data into a cluster that isn't balanced, or where the ingestion of data will lead to an imbalance of data.

  This can arise in an initial data loading, or in a case where you must insert a large volume of data into a single chunk, as is the case when you must insert at the beginning or end of the chunk range, as is the case for monotonically increasing or decreasing shard keys.

Preemptively splitting chunks increases cluster throughput for these operations, by reducing the overhead of migrating chunks that hold data during the write operation. MongoDB only creates splits after an insert operation and can migrate only a single chunk at a time. Chunk migrations are resource intensive and further complicated by large write volume to the migrating chunk.

Warning: You can only pre-split an empty collection. When you enable sharding for a collection that contains data MongoDB automatically creates splits. Subsequent attempts to create splits manually, can lead to unpredictable chunk ranges and sizes as well as inefficient or ineffective balancing behavior.

To create and migrate chunks manually, use the following procedure:

1. Split empty chunks in your collection by manually performing `split` (page 796) command on chunks.

   Example

   To create chunks for documents in the `myapp.users` collection, using the `email` field as the *shard key*, use the following operation in the `mongo` (page 908) shell:

   ```
   for ( var x=97; x<97+26; x++ ){
     for( var y=97; y<97+26; y+=6 ) {
       var prefix = String.fromCharCode(x) + String.fromCharCode(y);
       db.runCommand( { split : "myapp.users" , middle : { email : prefix } } );
   ```

```
    }
}
```

This assumes a collection size of 100 million documents.

2. Migrate chunks manually using the `moveChunk` (page 782) command:

   Example

   To migrate all of the manually created user profiles evenly, putting each prefix chunk on the next shard from the other, run the following commands in the mongo shell:

```
var shServer = [ "sh0.example.net", "sh1.example.net", "sh2.example.net", "sh3.example.net",
for ( var x=97; x<97+26; x++ ){
  for( var y=97; y<97+26; y+=6 ) {
    var prefix = String.fromCharCode(x) + String.fromCharCode(y);
    db.adminCommand({moveChunk : "myapp.users", find : {email : prefix}, to : shServer[(y-97
  }
}
```

   You can also let the balancer automatically distribute the new chunks. For an introduction to balancing, see *Shard Balancing* (page 366). For lower level information on balancing, see *Cluster Balancer* (page 378).

Modify Chunk Size

When you initialize a sharded cluster, [2] the default chunk size is 64 megabytes. this default chunk size works well for most deployments. however, if you notice that automatic migrations are incurring a level of i/o that your hardware cannot handle, you may want to reduce the chunk size. for the automatic splits and migrations, a small chunk size leads to more rapid and frequent migrations.

to modify the chunk size, use the following procedure:

1. connect to any `mongos` (page 905) in the cluster using the `mongo` (page 908) shell.
2. issue the following command to switch to the *Config Database Contents* (page 1013):

   ```
   use config
   ```

3. Issue the following `save()` (page 840) operation:

   ```
   db.settings.save( { _id:"chunksize", value: <size> } )
   ```

   Where the value of `<size>` reflects the new chunk size in megabytes. Here, you're essentially writing a document whose values store the global chunk size configuration value.

Note: The `chunkSize` (page 954) and `--chunkSize` (page 907) options, passed at runtime to the `mongos` (page 905) **do not** affect the chunk size after you have initialized the cluster. [1]

To eliminate confusion you should *always* set chunk size using the above procedure and never use the runtime options.

Modifying the chunk size has several limitations:

- Automatic splitting only occurs when inserting *documents* or updating existing documents.
- If you lower the chunk size it may take time for all chunks to split to the new size.

[2] The first `mongos` (page 905) that connects to a set of *config servers* initializes the sharded cluster.

- Splits cannot be "undone."

If you increase the chunk size, existing chunks must grow through insertion or updates until they reach the new size.

Migrate Chunks

In most circumstances, you should let the automatic balancer migrate *chunks* between *shards*. However, you may want to migrate chunks manually in a few cases:

- If you create chunks by *pre-splitting* the data in your collection, you will have to migrate chunks manually to distribute chunks evenly across the shards. Use pre-splitting in limited situations, to support bulk data ingestion.
- If the balancer in an active cluster cannot distribute chunks within the balancing window, then you will have to migrate chunks manually.

For more information on how chunks move between shards, see *Cluster Balancer* (page 378), in particular the section *Chunk Migration* (page 380).

To migrate chunks, use the `moveChunk` (page 782) command.

Note: To return a list of shards, use the `listShards` (page 774) command.

Specify shard names using the `addShard` (page 739) command using the `name` argument. If you do not specify a name in the `addShard` (page 739) command, MongoDB will assign a name automatically.

The following example assumes that the field `username` is the *shard key* for a collection named `users` in the `myapp` database, and that the value `smith` exists within the *chunk* you want to migrate.

To move this chunk, you would issue the following command from a `mongo` (page 908) shell connected to any `mongos` (page 905) instance.

```
db.adminCommand( { moveChunk : "myapp.users",
                   find : {username : "smith"},
                   to : "mongodb-shard3.example.net" } )
```

This command moves the chunk that includes the shard key value "smith" to the *shard* named `mongodb-shard3.example.net`. The command will block until the migration is complete.

See *Create Chunks (Pre-Splitting)* (page 393) for an introduction to pre-splitting. New in version 2.2: `moveChunk` (page 782) command has the: `_secondaryThrottle` parameter. When set to `true`, MongoDB ensures that changes to shards as part of chunk migrations replicate to *secondaries* throughout the migration operation. For more information, see *Require Replication before Chunk Migration (Secondary Throttle)* (page 398).

Warning: The `moveChunk` (page 782) command may produce the following error message:

```
The collection's metadata lock is already taken.
```

These errors occur when clients have too many open *cursors* that access the chunk you are migrating. You can either wait until the cursors complete their operation or close the cursors manually.

Strategies for Bulk Inserts in Sharded Clusters

Large bulk insert operations, including initial data ingestion or routine data import, can have a significant impact on a *sharded cluster*. For bulk insert operations, consider the following strategies:

- If the collection does not have data, then there is only one *chunk*, which must reside on a single shard. MongoDB must receive data, create splits, and distribute chunks to the available shards. To avoid this performance cost, you can pre-split the collection, as described in *Create Chunks (Pre-Splitting)* (page 393).

- You can parallelize import processes by sending insert operations to more than one `mongos` (page 905) instance. If the collection is empty, pre-split first, as described in *Create Chunks (Pre-Splitting)* (page 393).
- If your shard key increases monotonically during an insert then all the inserts will go to the last chunk in the collection, which will always end up on a single shard. Therefore, the insert capacity of the cluster will never exceed the insert capacity of a single shard.

  If your insert volume is never larger than what a single shard can process, then there is no problem; however, if the insert volume exceeds that range, and you cannot avoid a monotonically increasing shard key, then consider the following modifications to your application:

  – Reverse all the bits of the shard key to preserve the information while avoiding the correlation of insertion order and increasing sequence of values.

  – Swap the first and last 16-bit words to "shuffle" the inserts.

Example

The following example, in C++, swaps the leading and trailing 16-bit word of *BSON ObjectIds* generated so that they are no longer monotonically increasing.

```
using namespace mongo;
OID make_an_id() {
  OID x = OID::gen();
  const unsigned char *p = x.getData();
  swap( (unsigned short&) p[0], (unsigned short&) p[10] );
  return x;
}

void foo() {
  // create an object
  BSONObj o = BSON( "_id" << make_an_id() << "x" << 3 << "name" << "jane" );
  // now we might insert o into a sharded collection...
}
```

For information on choosing a shard key, see *Shard Key Selection* (page 365) and see *Shard Key Internals* (page 374) (in particular, *Operations and Reliability* (page 376) and *Choosing a Shard Key* (page 377)).

Note: For bulk inserts on sharded clusters, the `getLastError` (page 766) command alone is insufficient to verify success. Applications should must verify the success of bulk inserts in application logic.

33.2.3 Configure Behavior of Balancer Process in Sharded Clusters

The balancer is a process that runs on *one* of the `mongos` (page 905) instances in a cluster and ensures that *chunks* are evenly distributed throughout a sharded cluster. In most deployments, the default balancer configuration is sufficient for normal operation. However, administrators might need to modify balancer behavior depending on application or operational requirements. If you encounter a situation where you need to modify the behavior of the balancer, use the procedures described in this document.

For conceptual information about the balancer, see *Shard Balancing* (page 366) and *Cluster Balancer* (page 378).

Schedule a Window of Time for Balancing to Occur

You can schedule a window of time during which the balancer can migrate chunks, as described in the following procedures:

- *Schedule the Balancing Window* (page 399)
- *Remove a Balancing Window Schedule* (page 399).

The mongos (page 905) instances user their own local timezones to when respecting balancer window.

Configure Default Chunk Size

The default chunk size for a sharded cluster is 64 megabytes. In most situations, the default size is appropriate for splitting and migrating chunks. For information on how chunk size affects deployments, see details, see *Chunk Size* (page 379).

Changing the default chunk size affects chunks that are processes during migrations and auto-splits but does not retroactively affect all chunks.

To configure default chunk size, see *Modify Chunk Size* (page 394).

Change the Maximum Storage Size for a Given Shard

The maxSize field in the shards (page 1017) collection in the *config database* (page 1013) sets the maximum size for a shard, allowing you to control whether the balancer will migrate chunks to a shard. If dataSize (page 980) is above a shard's maxSize, the balancer will not move chunks to the shard. Also, the balancer will not move chunks off an overloaded shard. This must happen manually. The maxSize value only affects the balancer's selection of destination shards.

By default, maxSize is not specified, allowing shards to consume the total amount of available space on their machines if necessary.

You can set maxSize both when adding a shard and once a shard is running.

To set maxSize when adding a shard, set the addShard (page 739) command's maxSize parameter to the maximum size in megabytes. For example, the following command run in the mongo (page 908) shell adds a shard with a maximum size of 125 megabytes:

```
db.runCommand( { addshard : "example.net:34008", maxSize : 125 } )
```

To set maxSize on an existing shard, insert or update the maxSize field in the shards (page 1017) collection in the *config database* (page 1013). Set the maxSize in megabytes.

Example

Assume you have the following shard without a maxSize field:

```
{ "_id" : "shard0000", "host" : "example.net:34001" }
```

Run the following sequence of commands in the mongo (page 908) shell to insert a maxSize of 125 megabytes:

```
use config
db.shards.update( { _id : "shard0000" }, { $set : { maxSize : 125 } } )
```

To later increase the maxSize setting to 250 megabytes, run the following:

```
use config
db.shards.update( { _id : "shard0000" }, { $set : { maxSize : 250 } } )
```

Require Replication before Chunk Migration (Secondary Throttle)

New in version 2.2.1. You can configure the balancer to wait for replication to secondaries during migrations. You do so by enabling the balancer's `_secondaryThrottle` parameter, which reduces throughput (i.e., "throttles") in order to decrease the load on secondaries. You might do this, for example, if you have migration-caused I/O peaks that impact other workloads

When enabled, secondary throttle puts a `{ w : 2 }` write concern on deletes and on copies, which means the balancer waits for those operations to replicate to at least one secondary before migrating chunks.

You enable `_secondaryThrottle` directly in the `settings` (page 1017) collection in the *config database* (page 1013) by running the following commands from the `mongo` (page 908) shell:

```
use config
db.settings.update( { "_id" : "balancer" } , { $set : { "_secondaryThrottle" : true } , { upsert : tr
```

You also can enable secondary throttle when issuing the `moveChunk` (page 782) command by setting `_secondaryThrottle` to `true`. For more information, see `moveChunk` (page 782).

33.2.4 Manage Sharded Cluster Balancer

This page describes provides common administrative procedures related to balancing. For an introduction to balancing, see *Shard Balancing* (page 366). For lower level information on balancing, see *Cluster Balancer* (page 378).

See Also:

Configure Behavior of Balancer Process in Sharded Clusters (page 396)

Check the Balancer Lock

To see if the balancer process is active in your *cluster*, do the following:

1. Connect to any `mongos` (page 905) in the cluster using the `mongo` (page 908) shell.
2. Issue the following command to switch to the *Config Database Contents* (page 1013):

   ```
   use config
   ```

3. Use the following query to return the balancer lock:

   ```
   db.locks.find( { _id : "balancer" } ).pretty()
   ```

When this command returns, you will see output like the following:

```
{   "_id" : "balancer",
"process" : "mongos0.example.net:1292810611:1804289383",
  "state" : 2,
     "ts" : ObjectId("4d0f872630c42d1978be8a2e"),
   "when" : "Mon Dec 20 2010 11:41:10 GMT-0500 (EST)",
    "who" : "mongos0.example.net:1292810611:1804289383:Balancer:846930886",
    "why" : "doing balance round" }
```

This output confirms that:

- The balancer originates from the `mongos` (page 905) running on the system with the hostname `mongos0.example.net`.
- The value in the `state` field indicates that a `mongos` (page 905) has the lock. For version 2.0 and later, the value of an active lock is `2`; for earlier versions the value is `1`.

Optional

You can also use the following shell helper, which returns a boolean to report if the balancer is active:

```
sh.getBalancerState()
```

Schedule the Balancing Window

In some situations, particularly when your data set grows slowly and a migration can impact performance, it's useful to be able to ensure that the balancer is active only at certain times. Use the following procedure to specify a window during which the *balancer* will be able to migrate chunks:

1. Connect to any `mongos` (page 905) in the cluster using the `mongo` (page 908) shell.
2. Issue the following command to switch to the *Config Database Contents* (page 1013):

   ```
   use config
   ```

3. Use an operation modeled on the following example `update()` (page 842) operation to modify the balancer's window:

   ```
   db.settings.update({ _id : "balancer" }, { $set : { activeWindow : { start : "<start-time>", sto
   ```

   Replace `<start-time>` and `<end-time>` with time values using two digit hour and minute values (e.g `HH:MM`) that describe the beginning and end boundaries of the balancing window. These times will be evaluated relative to the time zone of each individual `mongos` (page 905) instance in the sharded cluster. For instance, running the following will force the balancer to run between 11PM and 6AM local time only:

   ```
   db.settings.update({ _id : "balancer" }, { $set : { activeWindow : { start : "23:00", stop : "6:
   ```

Note: The balancer window must be sufficient to *complete* the migration of all data inserted during the day.

As data insert rates can change based on activity and usage patterns, it is important to ensure that the balancing window you select will be sufficient to support the needs of your deployment.

Remove a Balancing Window Schedule

If you have *set the balancing window* (page 399) and wish to remove the schedule so that the balancer is always running, issue the following sequence of operations:

```
use config
db.settings.update({ _id : "balancer" }, { $unset : { activeWindow : true } })
```

Disable the Balancer

By default the balancer may run at any time and only moves chunks as needed. To disable the balancer for a short period of time and prevent all migration, use the following procedure:

1. Connect to any `mongos` (page 905) in the cluster using the `mongo` (page 908) shell.
2. Issue *one* of the following operations to disable the balancer:

```
sh.stopBalancer()
```

3. Later, issue *one* the following operations to enable the balancer:

```
sh.startBalancer()
```

Note: If a migration is in progress, the system will complete the in-progress migration. After disabling, you can use the following operation in the `mongo` (page 908) shell to determine if there are no migrations in progress:

```
use config
while( db.locks.findOne({_id: "balancer"}).state ) {
       print("waiting..."); sleep(1000);
}
```

The above process and the `sh.setBalancerState()` (page 869), `sh.startBalancer()` (page 871), and `sh.stopBalancer()` (page 871) helpers provide wrappers on the following process, which may be useful if you need to run this operation from a driver that does not have helper functions:

1. Connect to any `mongos` (page 905) in the cluster using the `mongo` (page 908) shell.
2. Issue the following command to switch to the *Config Database Contents* (page 1013):

```
use config
```

3. Issue the following update to disable the balancer:

```
db.settings.update( { _id: "balancer" }, { $set : { stopped: true } } , true );
```

4. To enable the balancer again, alter the value of "stopped" as follows:

```
db.settings.update( { _id: "balancer" }, { $set : { stopped: false } } , true );
```

Disable Balancing During Backups

If MongoDB migrates a *chunk* during a *backup* (page 67), you can end with an inconsistent snapshot of your *sharded cluster*. Never run a backup while the balancer is active. To ensure that the balancer is inactive during your backup operation:

- Set the *balancing window* (page 399) so that the balancer is inactive during the backup. Ensure that the backup can complete while you have the balancer disabled.
- *manually disable the balancer* (page 399) for the duration of the backup procedure.

Confirm that the balancer is not active using the `sh.getBalancerState()` (page 867) method before starting a backup operation. When the backup procedure is complete you can reactivate the balancer process.

33.2.5 Remove Shards from an Existing Sharded Cluster

To remove a *shard* you must ensure the shard's data is migrated to the remaining shards in the cluster. This procedure describes how to safely migrate data and how to remove a shard.

This procedure describes how to safely remove a *single* shard. *Do not* use this procedure to migrate an entire cluster to new hardware. To migrate an entire shard to new hardware, migrate individual shards as if they were independent replica sets.

To remove a shard, first connect to one of the cluster's `mongos` (page 905) instances using `mongo` (page 908) shell. Then follow the ordered sequence of tasks on this page:

1. *Ensure the Balancer Process is Active* (page 401)
2. *Determine the Name of the Shard to Remove* (page 401)
3. *Remove Chunks from the Shard* (page 401)
4. *Check the Status of the Migration* (page 401)
5. *Move Unsharded Data* (page 402)
6. *Finalize the Migration* (page 402)

Ensure the Balancer Process is Active

To successfully migrate data from a shard, the *balancer* process **must** be active. Check the balancer state using the `sh.getBalancerState()` (page 867) helper in the `mongo` (page 908) shell. For more information, see the section on *balancer operations* (page 399).

Determine the Name of the Shard to Remove

To determine the name of the shard, connect to a `mongos` (page 905) instance with the `mongo` (page 908) shell and either:

- Use the `listShards` (page 774) command, as in the following:

  ```
  db.adminCommand( { listShards: 1 } )
  ```

- Run either the `sh.status()` (page 871) or the `db.printShardingStatus()` (page 852) method.

The `shards._id` field lists the name of each shard.

Remove Chunks from the Shard

Run the `removeShard` (page 785) command. This begins "draining" chunks from the shard you are removing to other shards in the cluster. For example, for a shard named `mongodb0`, run:

```
db.runCommand( { removeShard: "mongodb0" } )
```

This operation returns immediately, with the following response:

```
{ msg : "draining started successfully" , state: "started" , shard :"mongodb0" , ok : 1 }
```

Depending on your network capacity and the amount of data, this operation can take from a few minutes to several days to complete.

Check the Status of the Migration

To check the progress of the migration at any stage in the process, run `removeShard` (page 785). For example, for a shard named `mongodb0`, run:

```
db.runCommand( { removeShard: "mongodb0" } )
```

The command returns output similar to the following:

```
{ msg: "draining ongoing" , state: "ongoing" , remaining: { chunks: NumberLong(42), dbs : NumberLong
```

In the output, the `remaining` document displays the remaining number of chunks that MongoDB must migrate to other shards and the number of MongoDB databases that have "primary" status on this shard.

Continue checking the status of the *removeShard* command until the number of chunks remaining is `0`. Then proceed to the next step.

Move Unsharded Data

If the shard is the *primary shard* for one or more databases in the cluster, then the shard will have unsharded data. If the shard is not the primary shard for any databases, skip to the next task, *Finalize the Migration* (page 402).

In a cluster, a database with unsharded collections stores those collections only on a single shard. That shard becomes the primary shard for that database. (Different databases in a cluster can have different primary shards.)

Warning: Do not perform this procedure until you have finished draining the shard.

1. To determine if the shard you are removing is the primary shard for any of the cluster's databases, issue one of the following methods:

   - `sh.status()` (page 871)
   - `db.printShardingStatus()` (page 852)

   In the resulting document, the `databases` field lists each database and its primary shard. For example, the following `database` field shows that the `products` database uses `mongodb0` as the primary shard:

   ```
   {  "_id" : "products",  "partitioned" : true,  "primary" : "mongodb0" }
   ```

2. To move a database to another shard, use the `movePrimary` (page 783) command. For example, to migrate all remaining unsharded data from `mongodb0` to `mongodb1`, issue the following command:

   ```
   db.runCommand( { movePrimary: "products", to: "mongodb1" })
   ```

   This command does not return until MongoDB completes moving all data, which may take a long time. The response from this command will resemble the following:

   ```
   { "primary" : "mongodb1", "ok" : 1 }
   ```

Finalize the Migration

To clean up all metadata information and finalize the removal, run `removeShard` (page 785) again. For example, for a shard named `mongodb0`, run:

```
db.runCommand( { removeShard: "mongodb0" } )
```

A success message appears at completion:

```
{ msg: "remove shard completed successfully" , stage: "completed", host: "mongodb0", ok : 1 }
```

Once the value of the `stage` field is "completed", you may safely stop the processes comprising the `mongodb0` shard.

33.3 Backup and Restore Sharded Clusters

33.3.1 Backup a Small Sharded Cluster with mongodump

Overview

If your *sharded cluster* holds a small data set, you can connect to a mongos (page 905) using mongodump (page 915). You can create backups of your MongoDB cluster, if your backup infrastructure can capture the entire backup in a reasonable amount of time and if you have a storage system that can hold the complete MongoDB data set.

Read *Sharded Cluster Backup Considerations* (page 68) for a high-level overview of important considerations as well as a list of alternate backup tutorials.

Important: By default mongodump (page 915) issue its queries to the non-primary nodes.

Procedure

Capture Data

Note: If you use mongodump (page 915) without specifying the a database or collection, mongodump (page 915) will capture collection data *and* the cluster meta-data from the *config servers* (page 368).

You cannot use the *--oplog* (page 916) option for mongodump (page 915) when capturing data from mongos (page 905). This option is only available when running directly against a *replica set* member.

You can perform a backup of a *sharded cluster* by connecting mongodump (page 915) to a mongos (page 905). Use the following operation at your system's prompt:

```
mongodump --host mongos3.example.net --port 27017
```

mongodump (page 915) will write *BSON* files that hold a copy of data stored in the *sharded cluster* accessible via the mongos (page 905) listening on port 27017 of the mongos3.example.net host.

Restore Data

Backups created with mongodump (page 915) do not reflect the chunks or the distribution of data in the sharded collection or collections. Like all mongodump (page 915) output, these backups contain separate directories for each database and *BSON* files for each collection in that database.

You can restore mongodump (page 915) output to any MongoDB instance, including a standalone, a *replica set*, or a new *sharded cluster*. When restoring data to sharded cluster, you must deploy and configure sharding before restoring data from the backup. See *Deploy a Sharded Cluster* (page 383) for more information.

33.3.2 Create Backup of a Sharded Cluster with Filesystem Snapshots

Overview

This document describes a procedure for taking a backup of all components of a sharded cluster. This procedure uses file system snapshots to capture a copy of the mongod (page 897) instance. An alternate procedure that uses

mongodump (page 915) to create binary database dumps when file-system snapshots are not available. See *Create Backup of a Sharded Cluster with Database Dumps* (page 405) for the alternate procedure.

See *Sharded Cluster Backup Considerations* (page 68) for a full higher level overview backing up a sharded cluster as well as links to other tutorials that provide alternate procedures.

Important: To capture a point-in-time backup from a sharded cluster you **must** stop *all* writes to the cluster. On a running production system, you can only capture an *approximation* of point-in-time snapshot.

Procedure

In this procedure, you will stop the cluster balancer and take a backup up of the *config database*, and then take backups of each shard in the cluster using a file-system snapshot tool. If you need an exact moment-in-time snapshot of the system, you will need to stop all application writes before taking the filesystem snapshots; otherwise the snapshot will only approximate a moment in time.

For approximate point-in-time snapshots, you can improve the quality of the backup while minimizing impact on the cluster by taking the backup from a secondary member of the replica set that provides each shard.

1. Disable the *balancer* process that equalizes the distribution of data among the *shards*. To disable the balancer, use the sh.stopBalancer() (page 871) method in the mongo (page 908) shell, and see the *Disable the Balancer* (page 399) procedure.

   > **Warning:** It is essential that you stop the balancer before creating backups. If the balancer remains active, your resulting backups could have duplicate data or miss some data, as *chunks* may migrate while recording backups.

2. Lock one member of each replica set in each shard so that your backups reflect the state of your database at the nearest possible approximation of a single moment in time. Lock these mongod (page 897) instances in as short of an interval as possible.

   To lock or freeze a sharded cluster, you must:

   - use the db.fsyncLock() (page 848) method in the mongo (page 908) shell connected to a single secondary member of the replica set that provides shard mongod (page 897) instance.
   - Shutdown one of the *config servers* (page 368), to prevent all metadata changes during the backup process.

3. Use mongodump (page 915) to backup one of the *config servers* (page 368). This backs up the cluster's metadata. You only need to back up one config server, as they all hold the same data.

   Issue this command against one of the config mongod (page 897) instances or via the mongos (page 905):

   ```
   mongodump --db config
   ```

4. Back up the replica set members of the shards that you locked. You may back up the shards in parallel. For each shard, create a snapshot. Use the procedures in *Use Filesystem Snapshots to Backup and Restore MongoDB Databases* (page 612).

5. Unlock all locked replica set members of each shard using the db.fsyncUnlock() (page 848) method in the mongo (page 908) shell.

6. Restore the balancer with the sh.startBalancer() (page 871) method according to the *Disable the Balancer* (page 399) procedure.

   Use the following command sequence when connected to the mongos (page 905) with the mongo (page 908) shell:

```
use config
sh.startBalancer()
```

33.3.3 Create Backup of a Sharded Cluster with Database Dumps

Overview

This document describes a procedure for taking a backup of all components of a sharded cluster. This procedure uses `mongodump` (page 915) to create dumps of the `mongod` (page 897) instance. An alternate procedure uses file system snapshots to capture the backup data, and may be more efficient in some situations if your system configuration allows file system backups. See *Create Backup of a Sharded Cluster with Filesystem Snapshots* (page 403).

See *Sharded Cluster Backup Considerations* (page 68) for a full higher level overview of backing up a sharded cluster as well as links to other tutorials that provide alternate procedures.

Important: To capture a point-in-time backup from a sharded cluster you **must** stop *all* writes to the cluster. On a running production system, you can only capture an *approximation* of point-in-time snapshot.

Procedure

In this procedure, you will stop the cluster balancer and take a backup up of the *config database*, and then take backups of each shard in the cluster using `mongodump` (page 915) to capture the backup data. If you need an exact moment-in-time snapshot of the system, you will need to stop all application writes before taking the filesystem snapshots; otherwise the snapshot will only approximate a moment of time.

For approximate point-in-time snapshots, you can improve the quality of the backup while minimizing impact on the cluster by taking the backup from a secondary member of the replica set that provides each shard.

1. Disable the *balancer* process that equalizes the distribution of data among the *shards*. To disable the balancer, use the `sh.stopBalancer()` (page 871) method in the `mongo` (page 908) shell, and see the *Disable the Balancer* (page 399) procedure.

   > **Warning:** It is essential that you stop the balancer before creating backups. If the balancer remains active, your resulting backups could have duplicate data or miss some data, as *chunks* migrate while recording backups.

2. Lock one member of each replica set in each shard so that your backups reflect the state of your database at the nearest possible approximation of a single moment in time. Lock these `mongod` (page 897) instances in as short of an interval as possible.

   To lock or freeze a sharded cluster, you must:

   - Shutdown one member of each replica set.

     Ensure that the *oplog* has sufficient capacity to allow these secondaries to catch up to the state of the primaries after finishing the backup procedure. See *Oplog* (page 282) for more information.

   - Shutdown one of the *config servers* (page 368), to prevent all metadata changes during the backup process.

3. Use `mongodump` (page 915) to backup one of the *config servers* (page 368). This backs up the cluster's metadata. You only need to back up one config server, as they all hold the same data.

   Issue this command against one of the config `mongod` (page 897) instances or via the `mongos` (page 905):

```
mongodump --journal --db config
```

4. Back up the replica set members of the shards that shut down using mongodump (page 915) and specifying the *--dbpath* (page 915) option. You may back up the shards in parallel. Consider the following invocation:

   ```
   mongodump --journal --dbpath /data/db/ --out /data/backup/
   ```

   You must run this command on the system where the mongod (page 897) ran. This operation will use journaling and create a dump of the entire mongod (page 897) instance with data files stored in http://docs.mongodb.org/v2.2/data/db/. mongodump (page 915) will write the output of this dump to the http://docs.mongodb.org/v2.2/data/backup/ directory.

5. Restart all stopped replica set members of each shard as normal and allow them to catch up with the state of the primary.

6. Restore the balancer with the sh.startBalancer() (page 871) method according to the *Disable the Balancer* (page 399) procedure.

   Use the following command sequence when connected to the mongos (page 905) with the mongo (page 908) shell:

   ```
   use config
   sh.startBalancer()
   ```

33.3.4 Restore a Single Shard

Overview

Restoring a single shard from backup with other unaffected shards requires a number of special considerations and practices. This document outlines the additional tasks you must perform when restoring a single shard.

Consider the following resources on backups in general as well as backup and restoration of sharded clusters specifically:

- *Sharded Cluster Backup Considerations* (page 68)
- *Restore Sharded Clusters* (page 407)
- *Backup Strategies for MongoDB Systems* (page 67)

Procedure

Always restore *sharded clusters* as a whole. When you restore a single shard, keep in mind that the *balancer* process might have moved *chunks* to or from this shard since the last backup. If that's the case, you must manually move those chunks, as described in this procedure.

1. Restore the shard as you would any other mongod (page 897) instance. See *Backup Strategies for MongoDB Systems* (page 67) for overviews of these procedures.

2. For all chunks that migrate away from this shard, you do not need to do anything at this time. You do not need to delete these documents from the shard because the chunks are automatically filtered out from queries by mongos (page 905). You can remove these documents from the shard, if you like, at your leisure.

3. For chunks that migrate to this shard after the most recent backup, you must manually recover the chunks using backups of other shards, or some other source. To determine what chunks have moved, view the changelog collection in the *Config Database Contents* (page 1013).

33.3.5 Restore Sharded Clusters

Overview

The procedure outlined in this document addresses how to restore an entire sharded cluster. For information on related backup procedures consider the following tutorials which describe backup procedures in greater detail:

- *Create Backup of a Sharded Cluster with Filesystem Snapshots* (page 403)
- *Create Backup of a Sharded Cluster with Database Dumps* (page 405)

The exact procedure used to restore a database depends on the method used to capture the backup. See the *Backup Strategies for MongoDB Systems* (page 67) document for an overview of backups with MongoDB, as well as *Sharded Cluster Backup Considerations* (page 68) which provides an overview of the high level concepts important for backing up sharded clusters.

Procedure

1. Stop all `mongod` (page 897) and `mongos` (page 905) processes.
2. If shard hostnames have changed, you must manually update the `shards` collection in the *Config Database Contents* (page 1013) to use the new hostnames. Do the following:
   (a) Start the three *config servers* (page 368) by issuing commands similar to the following, using values appropriate to your configuration:

   ```
   mongod --configsvr --dbpath /data/configdb --port 27019
   ```

   (b) Restore the *Config Database Contents* (page 1013) on each config server.
   (c) Start one `mongos` (page 905) instance.
   (d) Update the *Config Database Contents* (page 1013) collection named `shards` to reflect the new hostnames.
3. Restore the following:
   - Data files for each server in each *shard*. Because replica sets provide each production shard, restore all the members of the replica set or use the other standard approaches for restoring a replica set from backup. See the *Restore a Snapshot* (page 614) and *Restore a Database with mongorestore* (page 611) sections for details on these procedures.
   - Data files for each *config server* (page 368), if you have not already done so in the previous step.
4. Restart all the `mongos` (page 905) instances.
5. Restart all the `mongod` (page 897) instances.
6. Connect to a `mongos` (page 905) instance from a `mongo` (page 908) shell and use the `db.printShardingStatus()` (page 852) method to ensure that the cluster is operational, as follows:

   ```
   db.printShardingStatus()
   show collections
   ```

33.3.6 Schedule Backup Window for Sharded Clusters

Overview

In a *sharded cluster*, the balancer process is responsible for distributing sharded data around the cluster, so that each *shard* has roughly the same amount of data.

However, when creating backups from a sharded cluster it is important that you disable the balancer while taking backups to ensure that no chunk migrations affect the content of the backup captured by the backup procedure. Using the procedure outlined in the section *Disable the Balancer* (page 399) you can manually stop the balancer process temporarily. As an alternative you can use this procedure to define a balancing window so that the balancer is always disabled during your automated backup operation.

Procedure

If you have an automated backup schedule, you can disable all balancing operations for a period of time. For instance, consider the following command:

```
use config
db.settings.update( { _id : "balancer" }, { $set : { activeWindow : { start : "6:00", stop : "23:00"
```

This operation configures the balancer to run between 6:00am and 11:00pm, server time. Schedule your backup operation to run *and complete* outside of this time. Ensure that the backup can complete outside the window when the balancer is running *and* that the balancer can effectively balance the collection among the shards in the window allotted to each.

33.4 Application Development Patterns for Sharded Clusters

The following documents describe processes that application developers may find useful when developing applications that use data stored in a MongoDB sharded cluster. For some cases you will also want to consider the documentation of `http://docs.mongodb.org/v2.2/data-center-awareness`.

33.4.1 Tag Aware Sharding

For sharded clusters, MongoDB makes it possible to associate specific ranges of a *shard key* with a specific *shard* or subset of shards. This association dictates the policy of the cluster balancer process as it balances the *chunks* around the cluster. This capability enables the following deployment patterns:

- isolating a specific subset of data on specific set of shards.
- controlling the balancing policy so that in a geographically distributed cluster the most relevant portions of the data set reside on the shards with greatest proximity to the application servers.

This document describes the behavior, operation, and use of tag aware sharding in MongoDB deployments.

Note: Shard key range tags are entirely distinct from *replica set member tags* (page 308).

Behavior and Operations

Tags in a sharded cluster are pieces of metadata that dictate the policy and behavior of the cluster *balancer*. Using tags, you may associate individual shards in a cluster with one or more tags. Then, you can assign this tag string to a range of *shard key* values for a sharded collection. When migrating a chunk, the balancer will select a destination shard based on the configured tag ranges.

The balancer migrates chunks in tagged ranges to shards with those tags, if tagged shards are not balanced. [3]

---

[3] To migrate chunks in a tagged environment, the balancer selects a target shard with a tag range that has an *upper* bound that is *greater than* the migrating chunk's *lower* bound. If a shard with a matching tagged range exists, the balancer will migrate the chunk to that shard.

Note: Because a single chunk may span different tagged shard key ranges, the balancer may migrate chunks to tagged shards that contain values that exceed the upper bound of the selected tag range.

Example

Given a sharded collection with two configured tag ranges, such that:

- *Shard key* values between `100` and `200` have tags to direct corresponding chunks to shards tagged `NYC`.
- Shard Key values between `200` and `300` have tags to direct corresponding chunks to shards tagged `SFO`.

In this cluster, the balancer will migrate a chunk with shard key values ranging between `150` and `220` to a shard tagged `NYC`, since `150` is closer to `200` than `300`.

After configuring tags on shards and ranges of the shard key, the cluster may take some time to reach the proper distribution of data, depending on the division of chunks (i.e. splits) and the current distribution of data in the cluster. Once configured, the balancer will respect tag ranges during future *balancing rounds* (page 378).

Administer Shard Tags

Associate tags with a particular shard using the `sh.addShardTag()` (page 864) method when connected to a `mongos` (page 905) instance. A single shard may have multiple tags, and multiple shards may also have the same tag.

Example

The following example adds the tag `NYC` to two shards, and the tags `SFO` and `NRT` to a third shard:

```
sh.addShardTag("shard0000", "NYC")
sh.addShardTag("shard0001", "NYC")
sh.addShardTag("shard0002", "SFO")
sh.addShardTag("shard0002", "NRT")
```

You may remove tags from a particular shard using the `sh.removeShardTag()` (page 869) method when connected to a `mongos` (page 905) instance, as in the following example, which removes the `NRT` tag from a shard:

```
sh.removeShardTag("shard0002", "NRT")
```

Tag a Shard Key Range

To assign a tag to a range of shard keys use the `sh.addTagRange()` (page 865) method when connected to a `mongos` (page 905) instance. Any given shard key range may only have *one* assigned tag. You cannot overlap defined ranges, or tag the same range more than once.

Example

Given a collection named `users` in the `records` database, sharded by the `zipcode` field. The following operations assign:

- two ranges of zip codes in Manhattan and Brooklyn the `NYC` tag
- one range of zip codes in San Francisco the `SFO` tag

```
sh.addTagRange("records.users", { zipcode: "10001" }, { zipcode: "10281" }, "NYC")
sh.addTagRange("records.users", { zipcode: "11201" }, { zipcode: "11240" }, "NYC")
sh.addTagRange("records.users", { zipcode: "94102" }, { zipcode: "94135" }, "SFO")
```

Note: Shard rages are always inclusive of the lower value and exclusive of the upper boundary.

Remove a Tag From a Shard Key Range

The `mongod` (page 897) does not provide a helper for removing a tag range. You may delete tag assignment from a shard key range by removing the corresponding document from the `tags` (page 1018) collection of the `config` database.

Each document in the `tags` (page 1018) holds the *namespace* of the sharded collection and a minimum shard key value.

Example

The following example removes the `NYC` tag assignment for the range of zip codes within Manhattan:

```
use config
db.tags.remove({ _id: { ns: "records.users", min: { zipcode: "10001" }}, tag: "NYC" })
```

View Existing Shard Tags

The output from `sh.status()` (page 871) lists tags associated with a shard, if any, for each shard. A shard's tags exist in the shard's document in the `shards` (page 1017) collection of the `config` database. To return all shards with a specific tag, use a sequence of operations that resemble the following, which will return only those shards tagged with `NYC`:

```
use config
db.shards.find({ tags: "NYC" })
```

You can find tag ranges for all *namespaces* in the `tags` (page 1018) collection of the `config` database. The output of `sh.status()` (page 871) displays all tag ranges. To return all shard key ranges tagged with `NYC`, use the following sequence of operations:

```
use config
db.tags.find({ tags: "NYC" })
```

33.4.2 Enforce Unique Keys for Sharded Collections

Overview

The `unique` (page 819) constraint on indexes ensures that only one document can have a value for a field in a *collection*. For *sharded collections these unique indexes cannot enforce uniqueness* (page 1022) because insert and indexing operations are local to each shard. [4]

If your need to ensure that a field is always unique in all collections in a sharded environment, there are two options:

1. Enforce uniqueness of the *shard key* (page 365).

   MongoDB *can* enforce uniqueness for the *shard key*. For compound shard keys, MongoDB will enforce uniqueness on the *entire* key combination, and not for a specific component of the shard key.

[4] If you specify a unique index on a sharded collection, MongoDB will be able to enforce uniqueness only among the documents located on a single shard *at the time of creation*.

2. Use a secondary collection to enforce uniqueness.

   Create a minimal collection that only contains the unique field and a reference to a document in the main collection. If you always insert into a secondary collection *before* inserting to the main collection, MongoDB will produce an error if you attempt to use a duplicate key.

   Note: If you have a small data set, you may not need to shard this collection and you can create multiple unique indexes. Otherwise you can shard on a single unique key.

Always use the default *acknowledged* (page 124) *write concern* (page 124) in conjunction with a *recent MongoDB driver* (page 1061).

Unique Constraints on the Shard Key

Process

To shard a collection using the `unique` constraint, specify the `shardCollection` (page 794) command in the following form:

```
db.runCommand( { shardCollection : "test.users" , key : { email : 1 } , unique : true } );
```

Remember that the `_id` field index is always unique. By default, MongoDB inserts an `ObjectId` into the `_id` field. However, you can manually insert your own value into the `_id` field and use this as the shard key. To use the `_id` field as the shard key, use the following operation:

```
db.runCommand( { shardCollection : "test.users" } )
```

Warning: In any sharded collection where you are *not* sharding by the `_id` field, you must ensure uniqueness of the `_id` field. The best way to ensure `_id` is always unique is to use `ObjectId`, or another universally unique identifier (UUID.)

Limitations

- You can only enforce uniqueness on one single field in the collection using this method.
- If you use a compound shard key, you can only enforce uniqueness on the *combination* of component keys in the shard key.

In most cases, the best shard keys are compound keys that include elements that permit *write scaling* (page 375) and *query isolation* (page 376), as well as *high cardinality* (page 375). These ideal shard keys are not often the same keys that require uniqueness and requires a different approach.

Unique Constraints on Arbitrary Fields

If you cannot use a unique field as the shard key or if you need to enforce uniqueness over multiple fields, you must create another *collection* to act as a "proxy collection". This collection must contain both a reference to the original document (i.e. its `ObjectId`) and the unique key.

If you must shard this "proxy" collection, then shard on the unique key using the *above procedure* (page 411); otherwise, you can simply create multiple unique indexes on the collection.

Process

Consider the following for the "proxy collection:"

```
{
  "_id" : ObjectId("...")
  "email" ": "..."
}
```

The `_id` field holds the `ObjectId` of the *document* it reflects, and the `email` field is the field on which you want to ensure uniqueness.

To shard this collection, use the following operation using the `email` field as the *shard key*:

```
db.runCommand( { shardCollection : "records.proxy" , key : { email : 1 } , unique : true } );
```

If you do not need to shard the proxy collection, use the following command to create a unique index on the `email` field:

```
db.proxy.ensureIndex( { "email" : 1 }, {unique : true} )
```

You may create multiple unique indexes on this collection if you do not plan to shard the `proxy` collection.

To insert documents, use the following procedure in the *JavaScript shell* (page 908):

```
use records;

var primary_id = ObjectId();

db.proxy.insert({
   "_id" : primary_id
   "email" : "example@example.net"
})

// if: the above operation returns successfully,
// then continue:

db.information.insert({
   "_id" : primary_id
   "email": "example@example.net"
   // additional information...
})
```

You must insert a document into the `proxy` collection first. If this operation succeeds, the `email` field is unique, and you may continue by inserting the actual document into the `information` collection.

See Also:

The full documentation of: `db.collection.ensureIndex()` (page 819) and `shardCollection` (page 794).

Considerations

- Your application must catch errors when inserting documents into the "proxy" collection and must enforce consistency between the two collections.
- If the proxy collection requires sharding, you must shard on the single field on which you want to enforce uniqueness.

- To enforce uniqueness on more than one field using sharded proxy collections, you must have *one* proxy collection for *every* field for which to enforce uniqueness. If you create multiple unique indexes on a single proxy collection, you will *not* be able to shard proxy collections.

33.4.3 Convert a Replica Set to a Replicated Sharded Cluster

Overview

Following this tutorial, you will convert a single 3-member replica set to a cluster that consists of 2 shards. Each shard will consist of an independent 3-member replica set.

The tutorial uses a test environment running on a local system UNIX-like system. You should feel encouraged to "follow along at home." If you need to perform this process in a production environment, notes throughout the document indicate procedural differences.

The procedure, from a high level, is as follows:

1. Create or select a 3-member replica set and insert some data into a collection.
2. Start the config databases and create a cluster with a single shard.
3. Create a second replica set with three new `mongod` (page 897) instances.
4. Add the second replica set as a shard in the cluster.
5. Enable sharding on the desired collection or collections.

Process

Install MongoDB according to the instructions in the *MongoDB Installation Tutorial* (page 3).

Deploy a Replica Set with Test Data

If have an existing MongoDB *replica set* deployment, you can omit the this step and continue from *Deploy Sharding Infrastructure* (page 603).

Use the following sequence of steps to configure and deploy a replica set and to insert test data.

1. Create the following directories for the first replica set instance, named `firstset`:
   - `http://docs.mongodb.org/v2.2/data/example/firstset1`
   - `http://docs.mongodb.org/v2.2/data/example/firstset2`
   - `http://docs.mongodb.org/v2.2/data/example/firstset3`

   To create directories, issue the following command:

   ```
   mkdir -p /data/example/firstset1 /data/example/firstset2 /data/example/firstset3
   ```

2. In a separate terminal window or GNU Screen window, start three `mongod` (page 897) instances by running each of the following commands:

   ```
   mongod --dbpath /data/example/firstset1 --port 10001 --replSet firstset --oplogSize 700 --rest
   mongod --dbpath /data/example/firstset2 --port 10002 --replSet firstset --oplogSize 700 --rest
   mongod --dbpath /data/example/firstset3 --port 10003 --replSet firstset --oplogSize 700 --rest
   ```

Note: The `--oplogSize 700` (page 903) option restricts the size of the operation log (i.e. oplog) for each `mongod` (page 897) instance to 700MB. Without the `--oplogSize` (page 903) option, each `mongod` (page 897) reserves approximately 5% of the free disk space on the volume. By limiting the size of the oplog, each instance starts more quickly. Omit this setting in production environments.

---

3. In a `mongo` (page 908) shell session in a new terminal, connect to the mongodb instance on port 10001 by running the following command. If you are in a production environment, first read the note below.

   ```
   mongo localhost:10001/admin
   ```

   Note: Above and hereafter, if you are running in a production environment or are testing this process with `mongod` (page 897) instances on multiple systems, replace "localhost" with a resolvable domain, hostname, or the IP address of your system.

   ---

4. In the `mongo` (page 908) shell, initialize the first replica set by issuing the following command:

   ```
   db.runCommand({"replSetInitiate" :
                       {"_id" : "firstset", "members" : [{"_id" : 1, "host" : "localhost:10001"},
                                                         {"_id" : 2, "host" : "localhost:10002"},
                                                         {"_id" : 3, "host" : "localhost:10003"}
                ]}})
   {
           "info" : "Config now saved locally.  Should come online in about a minute.",
           "ok" : 1
   }
   ```

5. In the `mongo` (page 908) shell, create and populate a new collection by issuing the following sequence of JavaScript operations:

   ```
   use test
   switched to db test
   people = ["Marc", "Bill", "George", "Eliot", "Matt", "Trey", "Tracy", "Greg", "Steve", "Kristina
   for(var i=0; i<1000000; i++){
                                name = people[Math.floor(Math.random()*people.length)];
                                user_id = i;
                                boolean = [true, false][Math.floor(Math.random()*2)];
                                added_at = new Date();
                                number = Math.floor(Math.random()*10001);
                                db.test_collection.save({"name":name, "user_id":user_id, "boolean":
                               }
   ```

   The above operations add one million documents to the collection `test_collection`. This can take several minutes, depending on your system.

   The script adds the documents in the following form:

```
{ "_id" : ObjectId("4ed5420b8fc1dd1df5886f70"), "name" : "Greg", "user_id" : 4, "boolean" : true, "a
```

Deploy Sharding Infrastructure

This procedure creates the three config databases that store the cluster's metadata.

Note: For development and testing environments, a single config database is sufficient. In production environments, use three config databases. Because config instances store only the *metadata* for the sharded cluster, they have minimal

resource requirements.

1. Create the following data directories for three *config database* instances:

   - `http://docs.mongodb.org/v2.2/data/example/config1`
   - `http://docs.mongodb.org/v2.2/data/example/config2`
   - `http://docs.mongodb.org/v2.2/data/example/config3`

   Issue the following command at the system prompt:

   ```
   mkdir -p /data/example/config1 /data/example/config2 /data/example/config3
   ```

2. In a separate terminal window or GNU Screen window, start the config databases by running the following commands:

   ```
   mongod --configsvr --dbpath /data/example/config1 --port 20001
   mongod --configsvr --dbpath /data/example/config2 --port 20002
   mongod --configsvr --dbpath /data/example/config3 --port 20003
   ```

3. In a separate terminal window or GNU Screen window, start `mongos` (page 905) instance by running the following command:

   ```
   mongos --configdb localhost:20001,localhost:20002,localhost:20003 --port 27017 --chunkSize 1
   ```

   Note: If you are using the collection created earlier or are just experimenting with sharding, you can use a small `--chunkSize` (page 907) (1MB works well.) The default `chunkSize` (page 954) of 64MB means that your cluster must have 64MB of data before the MongoDB's automatic sharding begins working.

   In production environments, do not use a small shard size.

   The `configdb` (page 954) options specify the *configuration databases* (e.g. `localhost:20001`, `localhost:20002`, and `localhost:2003`). The `mongos` (page 905) instance runs on the default "MongoDB" port (i.e. `27017`), while the databases themselves are running on ports in the `30001` series. In the this example, you may omit the `--port 27017` (page 905) option, as `27017` is the default port.

4. Add the first shard in `mongos` (page 905). In a new terminal window or GNU Screen session, add the first shard, according to the following procedure:

   (a) Connect to the `mongos` (page 905) with the following command:

   ```
   mongo localhost:27017/admin
   ```

   (b) Add the first shard to the cluster by issuing the `addShard` (page 739) command:

   ```
   db.runCommand( { addShard : "firstset/localhost:10001,localhost:10002,localhost:10003" } )
   ```

   (c) Observe the following message, which denotes success:

   ```
   { "shardAdded" : "firstset", "ok" : 1 }
   ```

Deploy a Second Replica Set

This procedure deploys a second replica set. This closely mirrors the process used to establish the first replica set above, omitting the test data.

1. Create the following data directories for the members of the second replica set, named `secondset`:

- http://docs.mongodb.org/v2.2/data/example/secondset1
- http://docs.mongodb.org/v2.2/data/example/secondset2
- http://docs.mongodb.org/v2.2/data/example/secondset3

2. In three new terminal windows, start three instances of mongod (page 897) with the following commands:

```
mongod --dbpath /data/example/secondset1 --port 10004 --replSet secondset --oplogSize 700 --rest
mongod --dbpath /data/example/secondset2 --port 10005 --replSet secondset --oplogSize 700 --rest
mongod --dbpath /data/example/secondset3 --port 10006 --replSet secondset --oplogSize 700 --rest
```

Note: As above, the second replica set uses the smaller oplogSize (page 952) configuration. Omit this setting in production environments.

---

3. In the mongo (page 908) shell, connect to one mongodb instance by issuing the following command:

```
mongo localhost:10004/admin
```

4. In the mongo (page 908) shell, initialize the second replica set by issuing the following command:

```
db.runCommand({"replSetInitiate" :
                    {"_id" : "secondset",
                     "members" : [{"_id" : 1, "host" : "localhost:10004"},
                                  {"_id" : 2, "host" : "localhost:10005"},
                                  {"_id" : 3, "host" : "localhost:10006"}
              ]}})

{
     "info" : "Config now saved locally.  Should come online in about a minute.",
     "ok" : 1
}
```

5. Add the second replica set to the cluster. Connect to the mongos (page 905) instance created in the previous procedure and issue the following sequence of commands:

```
use admin
db.runCommand( { addShard : "secondset/localhost:10004,localhost:10005,localhost:10006" } )
```

This command returns the following success message:

```
{ "shardAdded" : "secondset", "ok" : 1 }
```

6. Verify that both shards are properly configured by running the listShards (page 774) command. View this and example output below:

```
db.runCommand({listShards:1})
{
       "shards" : [
              {
                     "_id" : "firstset",
                     "host" : "firstset/localhost:10001,localhost:10003,localhost:10002"
              },
              {
                     "_id" : "secondset",
                     "host" : "secondset/localhost:10004,localhost:10006,localhost:10005"
              }
       ],
     "ok" : 1
}
```

Enable Sharding

MongoDB must have *sharding* enabled on *both* the database and collection levels.

Enabling Sharding on the Database Level Issue the `enableSharding` (page 755) command. The following example enables sharding on the "test" database:

```
db.runCommand( { enableSharding : "test" } )
{ "ok" : 1 }
```

Create an Index on the Shard Key MongoDB uses the shard key to distribute documents between shards. Once selected, you cannot change the shard key. Good shard keys:

- have values that are evenly distributed among all documents,
- group documents that are often accessed at the same time into contiguous chunks, and
- allow for effective distribution of activity among shards.

Typically shard keys are compound, comprising of some sort of hash and some sort of other primary key. Selecting a shard key depends on your data set, application architecture, and usage pattern, and is beyond the scope of this document. For the purposes of this example, we will shard the "number" key. This typically would *not* be a good shard key for production deployments.

Create the index with the following procedure:

```
use test
db.test_collection.ensureIndex({number:1})
```

See Also:

The *Shard Key Overview* (page 365) and *Shard Key* (page 374) sections.

Shard the Collection Issue the following command:

```
use admin
db.runCommand( { shardCollection : "test.test_collection", key : {"number":1} })
{ "collectionsharded" : "test.test_collection", "ok" : 1 }
```

The collection `test_collection` is now sharded!

Over the next few minutes the Balancer begins to redistribute chunks of documents. You can confirm this activity by switching to the `test` database and running `db.stats()` (page 855) or `db.printShardingStatus()` (page 852).

As clients insert additional documents into this collection, `mongos` (page 905) distributes the documents evenly between the shards.

In the `mongo` (page 908) shell, issue the following commands to return statics against each cluster:

```
use test
db.stats()
db.printShardingStatus()
```

Example output of the `db.stats()` (page 855) command:

```
{
     "raw" : {
             "firstset/localhost:10001,localhost:10003,localhost:10002" : {
                     "db" : "test",
                     "collections" : 3,
                     "objects" : 973887,
                     "avgObjSize" : 100.33173458522396,
                     "dataSize" : 97711772,
                     "storageSize" : 141258752,
                     "numExtents" : 15,
                     "indexes" : 2,
                     "indexSize" : 56978544,
                     "fileSize" : 1006632960,
                     "nsSizeMB" : 16,
                     "ok" : 1
             },
             "secondset/localhost:10004,localhost:10006,localhost:10005" : {
                     "db" : "test",
                     "collections" : 3,
                     "objects" : 26125,
                     "avgObjSize" : 100.33286124401914,
                     "dataSize" : 2621196,
                     "storageSize" : 11194368,
                     "numExtents" : 8,
                     "indexes" : 2,
                     "indexSize" : 2093056,
                     "fileSize" : 201326592,
                     "nsSizeMB" : 16,
                     "ok" : 1
             }
     },
     "objects" : 1000012,
     "avgObjSize" : 100.33176401883178,
     "dataSize" : 100332968,
     "storageSize" : 152453120,
     "numExtents" : 23,
     "indexes" : 4,
     "indexSize" : 59071600,
     "fileSize" : 1207959552,
     "ok" : 1
}
```

Example output of the `db.printShardingStatus()` (page 852) command:

```
--- Sharding Status ---
sharding version: { "_id" : 1, "version" : 3 }
shards:
       {  "_id" : "firstset",  "host" : "firstset/localhost:10001,localhost:10003,localhost:10002" }
       {  "_id" : "secondset",  "host" : "secondset/localhost:10004,localhost:10006,localhost:10005"
databases:
       {  "_id" : "admin",  "partitioned" : false,  "primary" : "config" }
       {  "_id" : "test",  "partitioned" : true,  "primary" : "firstset" }
                test.test_collection chunks:
                                                secondset     5
                                                firstset      186

[...]
```

In a few moments you can run these commands for a second time to demonstrate that *chunks* are migrating from

`firstset` to `secondset`.

When this procedure is complete, you will have converted a replica set into a cluster where each shard is itself a replica set.

CHAPTER 34

Sharded Cluster Reference

Consider the following reference material relevant to sharded cluster use and administration.

- *Sharding Commands* (page 421)
- *Config Database Contents* (page 1013)
- *mongos* (page 904)

34.1 Sharding Commands

34.1.1 JavaScript Methods

`sh.addShard(host)`

Parameters

- **host** (*string*) – Specify the hostname of a database instance or a replica set configuration.

Use this method to add a database instance or replica set to a *sharded cluster*. This method must be run on a `mongos` (page 905) instance. The `host` parameter can be in any of the following forms:

```
[hostname]
[hostname]:[port]
[set]/[hostname]
[set]/[hostname],[hostname]:port
```

You can specify shards using the hostname, or a hostname and port combination if the shard is running on a non-standard port.

Warning: Do not use `localhost` for the hostname unless your *configuration server* is also running on `localhost`.

The optimal configuration is to deploy shards across *replica sets*. To add a shard on a replica set you must specify the name of the replica set and the hostname of at least one member of the replica set. You must specify at least one member of the set, but can specify all members in the set or another subset if desired. `sh.addShard()` (page 864) takes the following form:

If you specify additional hostnames, all must be members of the same replica set.

```
sh.addShard("set-name/seed-hostname")
```

Example

```
sh.addShard("repl0/mongodb3.example.net:27327")
```

The `sh.addShard()` (page 864) method is a helper for the `addShard` (page 739) command. The `addShard` (page 739) command has additional options which are not available with this helper.

See Also:

- `addShard` (page 739)
- *Sharded Cluster Administration* (page 368)
- *Add Shards to a Cluster* (page 387)
- *Remove Shards from an Existing Sharded Cluster* (page 400)

`sh.`**`enableSharding`**(*database*)

Parameters

- **database** (*string*) – Specify a database name to shard.

Enables sharding on the specified database. This does not automatically shard any collections, but makes it possible to begin sharding collections using `sh.shardCollection()` (page 870).

See Also:

`sh.shardCollection()` (page 870)

`sh.`**`shardCollection`**(*collection*, *key*, *unique*)

Parameters

- **collection** (*string*) – The namespace of the collection to shard.
- **key** (*document*) – A *document* containing a *shard key* that the sharding system uses to *partition* and distribute objects among the shards.
- **unique** (*boolean*) – When true, the `unique` option ensures that the underlying index enforces uniqueness so long as the unique index is a prefix of the shard key.

Shards the named collection, according to the specified *shard key*. Specify shard keys in the form of a *document*. Shard keys may refer to a single document field, or more typically several document fields to form a "compound shard key."

See Also:

`Size of Sharded Collection`

`sh.`**`splitFind`**(*namespace*, *query*)

Parameters

- **namespace** (*string*) – Specify the namespace (i.e. "`<database>.<collection>`") of the sharded collection that contains the chunk to split.
- **query** – Specify a query to identify a document in a specific chunk. Typically specify the *shard key* for a document as the query.

Splits the chunk containing the document specified by the `query` at its median point, creating two roughly equal chunks. Use `sh.splitAt()` (page 870) to split a collection in a specific point.

In most circumstances, you should leave chunk splitting to the automated processes. However, when initially deploying a *sharded cluster* it is necessary to perform some measure of *pre-splitting* using manual methods including `sh.splitFind()` (page 870).

`sh.`**`splitAt`**(*namespace*, *query*)

Parameters

- **namespace** (*string*) – Specify the namespace (i.e. "`<database>.<collection>`") of the sharded collection that contains the chunk to split.
- **query** (*document*) – Specify a query to identify a document in a specific chunk. Typically specify the *shard key* for a document as the query.

Splits the chunk containing the document specified by the `query` as if that document were at the "middle" of the collection, even if the specified document is not the actual median of the collection. Use this command to manually split chunks unevenly. Use the "`sh.splitFind()` (page 870)" function to split a chunk at the actual median.

In most circumstances, you should leave chunk splitting to the automated processes within MongoDB. However, when initially deploying a *sharded cluster* it is necessary to perform some measure of *pre-splitting* using manual methods including `sh.splitAt()` (page 870).

`sh.`**`moveChunk`**(*collection*, *query*, *destination*)

Parameters

- **collection** (*string*) – Specify the sharded collection containing the chunk to migrate.
- **query** – Specify a query to identify documents in a specific chunk. Typically specify the *shard key* for a document as the query.
- **destination** (*string*) – Specify the name of the shard that you wish to move the designated chunk to.

Moves the chunk containing the documents specified by the `query` to the shard described by `destination`.

This function provides a wrapper around the `moveChunk` (page 782). In most circumstances, allow the *balancer* to automatically migrate *chunks*, and avoid calling `sh.moveChunk()` (page 868) directly.

See Also:

"`moveChunk` (page 782)" and "*Sharding* (page 363)" for more information.

`sh.`**`setBalancerState`**(*state*)

Parameters

- **state** (*boolean*) – `true` enables the balancer if disabled, and `false` disables the balancer.

Enables or disables the *balancer*. Use `sh.getBalancerState()` (page 867) to determine if the balancer is currently enabled or disabled and `sh.isBalancerRunning()` (page 868) to check its current state.

See Also:

- `sh.enableBalancing()` (page 866)
- `sh.disableBalancing()` (page 866)
- `sh.getBalancerHost()` (page 867)
- `sh.getBalancerState()` (page 867)
- `sh.isBalancerRunning()` (page 868)

- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.**isBalancerRunning**()

Returns boolean

Returns true if the *balancer* process is currently running and migrating chunks and false if the balancer process is not running. Use sh.getBalancerState() (page 867) to determine if the balancer is enabled or disabled.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.**status**()

Returns a formatted report of the status of the *sharded cluster*, including data regarding the distribution of chunks.

sh.**addShardTag**(*shard*, *tag*)

New in version 2.2.

Parameters

- **shard** (*string*) – Specifies the name of the shard that you want to give a specific tag.
- **tag** (*string*) – Specifies the name of the tag that you want to add to the shard.

sh.addShardTag() (page 864) associates a shard with a tag or identifier. MongoDB uses these identifiers to direct *chunks* that fall within a tagged range to specific shards.

sh.addTagRange() (page 865) associates chunk ranges with tag ranges.

Always issue sh.addShardTag() (page 864) when connected to a mongos (page 905) instance.

Example

The following example adds three tags, NYC, LAX, and NRT, to three shards:

```
sh.addShardTag("shard0000", "NYC")
sh.addShardTag("shard0001", "LAX")
sh.addShardTag("shard0002", "NRT")
```

See Also:

- sh.addTagRange() (page 865) and

- sh.removeShardTag() (page 869)

sh.**addTagRange**(*namespace*, *minimum*, *maximum*, *tag*)

New in version 2.2.

Parameters

- **namespace** (*string*) – Specifies the namespace, in the form of <database>.<collection> of the sharded collection that you would like to tag.
- **minimum** (*document*) – Specifies the minimum value of the *shard key* range to include in the tag. Specify the minimum value in the form of <fieldname>:<value>. This value must be of the same BSON type or types as the shard key.
- **maximum** (*document*) – Specifies the maximum value of the shard key range to include in the tag. Specify the maximum value in the form of <fieldname>:<value>. This value must be of the same BSON type or types as the shard key.
- **tag** (*string*) – Specifies the name of the tag to attach the range specified by the minimum and maximum arguments to.

sh.addTagRange() (page 865) attaches a range of values of the shard key to a shard tag created using the sh.addShardTag() (page 864) method. Use this operation to ensure that the documents that exist within the specified range exist on shards that have a matching tag.

Always issue sh.addTagRange() (page 865) when connected to a mongos (page 905) instance.

Note: If you add a tag range to a collection using sh.addTagRange() (page 865), and then later drop the collection or its database, MongoDB does not remove tag association. If you later create a new collection with the same name, the old tag association will apply to the new collection.

Example

Given a shard key of {STATE:1,ZIP:1}, create a tag range covering ZIP codes in New York State:

```
sh.addTagRange( "exampledb.collection",
        {STATE: "NY", ZIP: {minKey:1}},
        {STATE:"NY", ZIP: {maxKey:1}},
        "NY"
        )
```

See Also:

sh.addShardTag() (page 864), sh.removeShardTag() (page 869)

sh.**removeShardTag**(*shard*, *tag*)

New in version 2.2.

Parameters

- **shard** (*string*) – Specifies the name of the shard that you want to remove a tag from.
- **tag** (*string*) – Specifies the name of the tag that you want to remove from the shard.

Removes the association between a tag and a shard.

Always issue sh.removeShardTag() (page 869) when connected to a mongos (page 905) instance.

See Also:

sh.addShardTag() (page 864), sh.addTagRange() (page 865)

sh.**help**()

Returns a basic help text for all sharding related shell functions.

34.1.2 Database Commands

The following database commands support *sharded clusters*.

addShard

Parameters

- **hostname** (*string*) – a hostname or replica-set/hostname string.
- **name** (*string*) – Optional. Unless specified, a name will be automatically provided to uniquely identify the shard.
- **maxSize** (*integer*) – Optional, megabytes. Limits the maximum size of a shard. If maxSize is 0 then MongoDB will not limit the size of the shard.

Use the addShard (page 739) command to add a database instance or replica set to a *sharded cluster*. You must run this command when connected a mongos (page 905) instance.

The command takes the following form:

```
{ addShard: "<hostname><:port>" }
```

Example

```
db.runCommand({addShard: "mongodb0.example.net:27027"})
```

Replace <hostname><:port> with the hostname and port of the database instance you want to add as a shard.

Warning: Do not use localhost for the hostname unless your *configuration server* is also running on localhost.

The optimal configuration is to deploy shards across *replica sets*. To add a shard on a replica set you must specify the name of the replica set and the hostname of at least one member of the replica set. You must specify at least one member of the set, but can specify all members in the set or another subset if desired. addShard (page 739) takes the following form:

```
{ addShard: "replica-set/hostname:port" }
```

Example

```
db.runCommand( { addShard: "repl0/mongodb3.example.net:27327"} )
```

If you specify additional hostnames, all must be members of the same replica set.

Send this command to only one mongos (page 905) instance, it will store shard configuration information in the *config database*.

Note: Specify a maxSize when you have machines with different disk capacities, or if you want to limit the amount of data on some shards.

The `maxSize` constraint prevents the *balancer* from migrating chunks to the shard when the value of `mem.mapped` (page 970) exceeds the value of `maxSize`.

See Also:

- `sh.addShard()` (page 864)
- *Sharded Cluster Administration* (page 368)
- *Add Shards to a Cluster* (page 387)
- *Remove Shards from an Existing Sharded Cluster* (page 400)

`listShards`

Use the `listShards` (page 774) command to return a list of configured shards. The command takes the following form:

```
{ listShards: 1 }
```

`enableSharding`

The `enableSharding` (page 755) command enables sharding on a per-database level. Use the following command form:

```
{ enableSharding: "<database name>" }
```

Once you've enabled sharding in a database, you can use the `shardCollection` (page 794) command to begin the process of distributing data among the shards.

`shardCollection`

The `shardCollection` (page 794) command marks a collection for sharding and will allow data to begin distributing among shards. You must run `enableSharding` (page 755) on a database before running the `shardCollection` (page 794) command.

```
{ shardCollection: "<db>.<collection>", key: <shardkey> }
```

This enables sharding for the collection specified by `<collection>` in the database named `<db>`, using the key `<shardkey>` to distribute documents among the shard. `<shardkey>` is a document, and takes the same form as an *index specification document* (page 140).

Choosing the right shard key to effectively distribute load among your shards requires some planning.

See Also:

Sharding (page 363) for more information related to sharding. Also consider the section on *Shard Key Selection* (page 365) for documentation regarding shard keys.

> **Warning:** There's no easy way to disable sharding after running `shardCollection` (page 794). In addition, you cannot change shard keys once set. If you must convert a sharded cluster to a *standalone* node or *replica set*, you must make a single backup of the entire cluster and then restore the backup to the standalone `mongod` (page 897) or the replica set..

`shardingState`

`shardingState` (page 795) is an admin command that reports if `mongod` (page 897) is a member of a *sharded cluster*. `shardingState` (page 795) has the following prototype form:

```
{ shardingState: 1 }
```

For `shardingState` (page 795) to detect that a `mongod` (page 897) is a member of a sharded cluster, the `mongod` (page 897) must satisfy the following conditions:

1. the mongod (page 897) is a primary member of a replica set, and
2. the mongod (page 897) instance is a member of a sharded cluster.

If shardingState (page 795) detects that a mongod (page 897) is a member of a sharded cluster, shardingState (page 795) returns a document that resembles the following prototype:

```
{
  "enabled" : true,
  "configServer" : "<configdb-string>",
  "shardName" : "<string>",
  "shardHost" : "string:",
  "versions" : {
       "<database>.<collection>" : Timestamp(<...>),
       "<database>.<collection>" : Timestamp(<...>)
  },
  "ok" : 1
}
```

Otherwise, shardingState (page 795) will return the following document:

```
{ "note" : "from execCommand", "ok" : 0, "errmsg" : "not master" }
```

The response from shardingState (page 795) when used with a *config server* is:

```
{ "enabled": false, "ok": 1 }
```

Note: mongos (page 905) instances do not provide the shardingState (page 795).

> **Warning:** This command obtains a write lock on the affected database and will block other operations until it has completed; however, the operation is typically short lived.

removeShard

Starts the process of removing a shard from a *cluster*. This is a multi-stage process. Begin by issuing the following command:

```
{ removeShard : "[shardName]" }
```

The balancer will then migrate chunks from the shard specified by [shardName]. This process happens slowly to avoid placing undue load on the overall cluster.

The command returns immediately, with the following message:

```
{ msg : "draining started successfully" , state: "started" , shard: "shardName" , ok : 1 }
```

If you run the command again, you'll see the following progress output:

```
{ msg: "draining ongoing" , state: "ongoing" , remaining: { chunks: 23 , dbs: 1 }, ok: 1 }
```

The remaining *document* specifies how many chunks and databases remain on the shard. Use db.printShardingStatus() (page 852) to list the databases that you must move from the shard.

Each database in a sharded cluster has a primary shard. If the shard you want to remove is also the primary of one of the cluster's databases, then you must manually move the database to a new shard. This can be only after the shard is empty. See the movePrimary (page 783) command for details.

After removing all chunks and databases from the shard, you may issue the command again, to return:

```
{ msg: "remove shard completed successfully , stage: "completed", host: "shardName", ok : 1 }
```

Part IX

Application Development

MongoDB provides language-specific client libraries called *drivers* that let you develop applications to interact with your databases.

This page lists the documents, tutorials, and reference pages that describe application development. For API-level documentation, see *MongoDB Drivers and Client Libraries* (page 435).

For an overview of topics with which every MongoDB application developer will want familiarity, see the *aggregation* (page 193) and *indexes* (page 239) documents. For an introduction to basic MongoDB use, see the *administration tutorials* (page 595).

See Also:

Core MongoDB Operations (CRUD) (page 109) section and the *FAQ: MongoDB for Application Developers* (page 639) document. Developers also should be familiar with the *Using the mongo Shell* (page 463) shell and the MongoDB *query and update operators* (page 882).

Development Considerations

The following documents outline basic application development topics:

35.1 MongoDB Drivers and Client Libraries

Applications communicate with MongoDB by way of a client library or driver that handles all interaction with the database in language appropriate and sensible manner. See the following pages for more information about the MongoDB drivers:

- JavaScript (Language Center, docs)
- Python (Language Center, docs)
- Ruby (Language Center, docs)
- PHP (Language Center, docs)
- Perl (Language Center, docs)
- Java (Language Center, docs)
- Scala (Language Center, docs)
- C# (Language Center, docs)
- C (Language Center, docs)
- C++ (Language Center, docs)
- Haskell (Language Center, docs)
- Erlang (Language Center, docs)

35.2 Optimization Strategies for MongoDB Applications

35.2.1 Overview

There are many factors that can affect performance of operations in MongoDB, including index use, query structure, data modeling, application design and architecture, as well as operational factors including architecture and system

configuration. This document addresses key application optimization strategies, and includes examples and links to relevant reference material.

See Also:

Optimizing Performance (page 197), *FAQ: MongoDB Fundamentals* (page 635), and *FAQ: MongoDB for Application Developers* (page 639).

35.2.2 Strategies

This section describes techniques for optimizing database performance with MongoDB with particular attention to query performance and basic client operations.

Use Indexes

For commonly issued queries, create *indexes* (page 239). If a query searches multiple fields, create a *compound index* (page 243). Scanning an index is much faster than scanning a collection. The indexes structures are smaller than the documents reference, and store references in order.

Example

If you have a `posts` collection containing blog posts, and if you regularly issue a query that sorts on the `author_name` field, then you can optimize the query by creating an index on the `author_name` field:

```
db.posts.ensureIndex( { author_name : 1 } )
```

Indexes also improve efficiency on queries that routinely sort on a given field.

Example

If you regularly issue a query that sorts on the `timestamp` field, then you can optimize the query by creating an index on the `timestamp` field:

Creating this index:

```
db.posts.ensureIndex( { timestamp : 1 } )
```

Optimizes this query:

```
db.posts.find().sort( { timestamp : -1 } )
```

Because MongoDB can read indexes in both ascending and descending order, the direction of a single-key index does not matter.

Indexes support queries, update operations, and some phases of the *aggregation pipeline* (page 197).

Index keys that are of the `BinData` type are more efficiently stored in the index if:

- the binary subtype value is in the range of 0-7 or 128-135, and
- the length of the byte array is: 0, 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 20, 24, or 32.

Limit Results

MongoDB *cursors* return results in groups of multiple documents. If you know the number of results you want, you can reduce the demand on network resources by issuing the `cursor.limit()` (page 807) method.

This is typically used in conjunction with sort operations. For example, if you need only 10 results from your query to the `posts` collection, you would issue the following command:

```
db.posts.find().sort( { timestamp : -1 } ).limit(10)
```

For more information on limiting results, see `cursor.limit()` (page 807)

Use Projections to Return Only Necessary Data

When you need only a subset of fields from documents, you can achieve better performance by returning only the fields you need:

For example, if in your query to the `posts` collection, you need only the `timestamp`, `title`, `author`, and `abstract` fields, you would issue the following command:

```
db.posts.find( {}, { timestamp : 1 , title : 1 , author : 1 , abstract : 1} ).sort( { timestamp : -1
```

For more information on using projections, see *Result Projections* (page 115).

Use the Database Profiler to Evaluate Performance

MongoDB provides a database profiler that shows performance characteristics of each operation against the database. Use the profiler to locate any queries or write operations that are running slow. You can use this information, for example, to determine what indexes to create.

For more information, see *Database Profiling* (page 60).

Use `db.currentOp()` to Evaluate Performance

The `db.currentOp()` (page 846) method reports on current operations running on a `mongod` (page 897) instance. For documentation of the output of `db.currentOp()` (page 846) see *Current Operation Reporting* (page 998).

Use `$explain` to Evaluate Performance

The `explain()` (page 805) method returns statistics on a query, and reports the index MongoDB selected to fulfill the query, as well as information about the internal operation of the query.

Example

To use `explain()` (page 805) on a query for documents matching the expression `{ a: 1 }`, in the collection `records`, use an operation that resembles the following in the `mongo` (page 908) shell:

```
db.records.find( { a: 1 } ).explain()
```

Use `$hint` to Select a Particular Index

In most cases the *query optimizer* (page 118) selects the optimal index for a specific operation; however, you can force MongoDB to use a specific index using the `hint()` (page 806) method. Use `hint()` (page 806) to support performance testing, or on some queries where you must select a field or field included in several indexes.

Use the Increment Operator to Perform Operations Server-Side

Use MongoDB's `$inc` (page 699) operator to increment or decrement values in documents. The operator increments the value of the field on the server side, as an alternative to selecting a document, making simple modifications in the client and then writing the entire document to the server. The `$inc` (page 699) operator can also help avoid race conditions, which would result when two application instances queried for a document, manually incremented a field, and saved the entire document back at the same time.

Perform Server-Side Code Execution

For some kinds of operations, you can perform operations on the `mongod` (page 897) server itself rather than writing a client application to perform a simple task. This can eliminate network overhead for client operations for some basic administrative operations. Consider the following example:

Example

For example, if you want to remove a field from all documents in a collection, performing the operation directly on the server is more efficient than transmitting the collection to your client and back again.

For more information, see the *Server-side JavaScript* (page 438) page.

Use Capped Collections

Capped Collections (page 440) are circular, fixed-size collections that keep documents well-ordered, even without the use of an index. This means that capped collections can receive very high-speed writes and sequential reads.

These collections are particularly useful for keeping log files but are not limited to that purpose. Use capped collections where appropriate.

Use Natural Order

To return documents in the order they exist on disk, return sorted operations using the `$natural` (page 704) operator. *Natural order* does not use indexes but can be fast for operations when you want to select the first or last items on disk. This is particularly useful for capped collections.

See Also:

`sort()` (page 813) and `limit()` (page 807).

35.3 Server-side JavaScript

MongoDB supports server-side execution of JavaScript code within the database process.

Note: The JavaScript code execution takes a JavaScript lock: each `mongod` (page 897) can only execute a single JavaScript operation at a time.

You can disable all server-side execution of JavaScript, by passing the *--noscripting* (page 901) option on the command line or setting noscripting (page 949) in a configuration file.

35.3.1 Map-Reduce

MongoDB performs the execution of JavaScript functions for *Map-Reduce* (page 223) operations on the server. Within these JavaScript functions, you must not access the database for any reason, including to perform reads.

See the db.collection.mapReduce() (page 832) and the *Map-Reduce* (page 223) documentation for more information, including examples of map-reduce. See *map-reduce concurrency* (page 228) section for concurrency information for map-reduce.

35.3.2 eval Command

The eval (page 755) command, and the corresponding mongo (page 908) shell method db.eval() (page 846), evaluates JavaScript functions on the database server. This command may be useful if you need to touch a lot of data lightly since the network transfer of the data could become a bottleneck if performing these operations on the client-side.

Warning: By default, eval (page 755) command requires a write lock. As such eval (page 755) will block all other read and write operations while it runs. Because only a single JavaScript process can run at a time, *do not* run mapReduce (page 775), group (page 769), queries with the $where (page 720) or any other operation that requires JavaScript execution within eval (page 755) operations.

See eval (page 755) command and db.eval() (page 846) documentation for more information, including examples.

35.3.3 Running .js files via a mongo shell Instance on the Server

Running a JavaScript (.js) file using a mongo (page 908) shell instance on the server is a good technique for performing batch administrative work. When you run mongo (page 908) shell on the server, connecting via the localhost interface, the connection is fast with low latency. Additionally, this technique has the advantage over the eval (page 755) command since the command eval (page 755) blocks all other operations.

35.3.4 $where Operator

To perform *Read Operations* (page 111), in addition to the standard operators (e.g. $gt (page 697), $lt (page 700)), with the $where (page 720) operator, you can also express the query condition either as a string or a full JavaScript function that specifies a SQL-like WHERE clause. However, use the standard operators whenever possible since $where (page 720) operations have significantly slower performance.

Warning: Do not write to the database within the $where (page 720) JavaScript function.

See $where (page 720) documentation for more information, including examples.

35.3.5 Storing Functions Server-side

Note: We do **not** recommend using server-side stored functions if possible.

There is a special system collection named `system.js` that can store JavaScript functions for reuse.

To store a function, you can use the `db.collection.save()` (page 840), as in the following example:

```
db.system.js.save(
   {
     _id : "myAddFunction" ,
     value : function (x, y){ return x + y; }
   }
);
```

- The `_id` field holds the name of the function and is unique per database.
- The `value` field holds the function definition

Once you save a function in the `system.js` collection, you can use the function from any JavaScript context (e.g. *eval* (page 439), *$where* (page 439), *map-reduce* (page 439)).

Consider the following example from the `mongo` (page 908) shell that first saves a function named `echoFunction` to the `system.js` collection and calls the function using *db.eval()* (page 439):

```
db.system.js.save(
                    { _id: "echoFunction",
                      value : function(x) { return x; }
                    }
                  )

db.eval( "echoFunction( 'test' )" )
```

See http://github.com/mongodb/mongo/tree/master/jstests/storefunc.js for a full example. New in version 2.1: In the `mongo` (page 908) shell, you can use `db.loadServerScripts()` (page 851) to load all the scripts saved in the `system.js` collection for the current db. Once loaded, you can invoke the functions directly in the shell, as in the following example:

```
db.loadServerScripts();

echoFunction(3);

myAddFunction(3, 5);
```

35.3.6 Concurrency

Refer to the individual method or operator documentation for any concurrency information. See also the *concurrency table* (page 654).

35.4 Capped Collections

Capped collections are fixed-size collections that support high-throughput operations that insert, retrieve, and delete documents based on insertion order. Capped collections work in a way similar to circular buffers: once a collection fills its allocated space, it makes room for new documents by overwriting the oldest documents in the collection.

Capped collections have the following behaviors:

- Capped collections guarantee preservation of the insertion order. As a result, queries do not need an index to return documents in insertion order. Without this indexing overhead, they can support higher insertion throughput.
- Capped collections guarantee that insertion order is identical to the order on disk (*natural order*) and do so by prohibiting updates that increase document size. Capped collections only allow updates that fit the original document size, which ensures a document does not change its location on disk.
- Capped collections automatically remove the oldest documents in the collection without requiring scripts or explicit remove operations.

For example, the *oplog.rs* collection that stores a log of the operations in a *replica set* uses a capped collection. Consider the following potential uses cases for capped collections:

- Store log information generated by high-volume systems. Inserting documents in a capped collection without an index is close to the speed of writing log information directly to a file system. Furthermore, the built-in *first-in-first-out* property maintains the order of events, while managing storage use.
- Cache small amounts of data in a capped collections. Since caches are read rather than write heavy, you would either need to ensure that this collection *always* remains in the working set (i.e. in RAM) *or* accept some write penalty for the required index or indexes.

35.4.1 Recommendations and Restrictions

- You cannot shard a capped collection.
- Capped collections created after 2.2 have an `_id` field and an index on the `_id` field by default. Capped collections created before 2.2 do not have an index on the `_id` field by default. If you are using capped collections with replication prior to 2.2, you should explicitly create an index on the `_id` field.
- You *can* update documents in a collection after inserting them; *however*, these updates *cannot* cause the documents to grow. If the update operation causes the document to grow beyond their original size, the update operation will fail.

  If you plan to update documents in a capped collection, remember to create an index to prevent update operations that require a table scan.
- You cannot delete documents from a capped collection. To remove all records from a capped collection, use the 'emptycapped' command. To remove the collection entirely, use the `drop()` (page 818) method.

Warning: If you have a capped collection in a *replica set* outside of the `local` database, before 2.2, you should create a unique index on `_id`. Ensure uniqueness using the `unique: true` option to the `ensureIndex()` (page 819) method or by using an *ObjectId* for the `_id` field. Alternately, you can use the `autoIndexId` option to `create` (page 751) when creating the capped collection, as in the *Query a Capped Collection* (page 442) procedure.

- Use natural ordering to retrieve the most recently inserted elements from the collection efficiently. This is (somewhat) analogous to tail on a log file.

35.4.2 Procedures

Create a Capped Collection

You must create capped collections explicitly using the `createCollection()` (page 845) method, which is a helper in the `mongo` (page 908) shell for the `create` (page 751) command. When creating a capped collection you must specify the maximum size of the collection in bytes, which MongoDB will pre-allocate for the collection. The size of the capped collection includes a small amount of space for internal overhead.

```
db.createCollection("mycoll", {capped:true, size:100000})
```

See Also:

db.createCollection() (page 845) and create (page 751).

Query a Capped Collection

If you perform a find() (page 820) on a capped collection with no ordering specified, MongoDB guarantees that the ordering of results is the same as the insertion order.

To retrieve documents in reverse insertion order, issue find() (page 820) along with the sort() (page 813) method with the $natural (page 704) parameter set to -1, as shown in the following example:

```
db.cappedCollection.find().sort( { $natural: -1 } )
```

Check if a Collection is Capped

Use the db.collection.isCapped() (page 832) method to determine if a collection is capped, as follows:

```
db.collection.isCapped()
```

Convert a Collection to Capped

You can convert a non-capped collection to a capped collection with the convertToCapped (page 748) command:

```
db.runCommand({"convertToCapped": "mycoll", size: 100000});
```

The size parameter specifies the size of the capped collection in bytes. Changed in version 2.2: Before 2.2, capped collections did not have an index on _id unless you specified autoIndexId to the create (page 751), after 2.2 this became the default.

Automatically Remove Data After a Specified Period of Time

For additional flexibility when expiring data, consider MongoDB's *TTL* indexes, as described in *Expire Data from Collections by Setting TTL* (page 458). These indexes allow you to expire and remove data from normal collections using a special type, based on the value of a date-typed field and a TTL value for the index.

TTL Collections (page 458) are not compatible with capped collections.

Tailable Cursor

You can use a tailable cursor with capped collections. Similar to the Unix tail -f command, the tailable cursor "tails" the end of a capped collection. As new documents are inserted into the capped collection, you can use the tailable cursor to continue retrieving documents.

See *Create Tailable Cursor* (page 451) for information on creating a tailable cursor.

See Also:

- *Replica Set Considerations and Behaviors for Applications and Development* (page 303)
- *Indexing Strategies* (page 257)
- *Aggregation Framework* (page 195)

- *Map-Reduce* (page 223)
- *Connection String URI Format* (page 955)

CHAPTER 36

Application Design Patterns for MongoDB

The following documents provide patterns for developing application features:

36.1 Perform Two Phase Commits

36.1.1 Synopsis

This document provides a pattern for doing multi-document updates or "transactions" using a two-phase commit approach for writing data to multiple documents. Additionally, you can extend this process to provide a *rollback* (page 449) like functionality.

36.1.2 Background

Operations on a single *document* are always atomic with MongoDB databases; however, operations that involve multiple documents, which are often referred to as "transactions," are not atomic. Since documents can be fairly complex and contain multiple "nested" documents, single-document atomicity provides necessary support for many practical use cases.

Thus, without precautions, success or failure of the database operation cannot be "all or nothing," and without support for multi-document transactions it's possible for an operation to succeed for some operations and fail with others. When executing a transaction composed of several sequential operations the following issues arise:

- Atomicity: if one operation fails, the previous operation within the transaction must "rollback" to the previous state (i.e. the "nothing," in "all or nothing.")
- Isolation: operations that run concurrently with the transaction operation set must "see" a consistent view of the data throughout the transaction process.
- Consistency: if a major failure (i.e. network, hardware) interrupts the transaction, the database must be able to recover a consistent state.

Despite the power of single-document atomic operations, there are cases that require multi-document transactions. For these situations, you can use a two-phase commit, to provide support for these kinds of multi-document updates.

Because documents can represent both pending data and states, you can use a two-phase commit to ensure that data is consistent, and that in the case of an error, the state that preceded the transaction is *recoverable* (page 449).

Note: Because only single-document operations are atomic with MongoDB, two-phase commits can only offer transaction-*like* semantics. It's possible for applications to return intermediate data at intermediate points during the two-phase commit or rollback.

36.1.3 Pattern

Overview

The most common example of transaction is to transfer funds from account A to B in a reliable way, and this pattern uses this operation as an example. In a relational database system, this operation would encapsulate subtracting funds from the source (`A`) account and adding them to the destination (`B`) within a single atomic transaction. For MongoDB, you can use a two-phase commit in these situations to achieve a compatible response.

All of the examples in this document use the `mongo` (page 908) shell to interact with the database, and assume that you have two collections: First, a collection named `accounts` that will store data about accounts with one account per document, and a collection named `transactions` which will store the transactions themselves.

Begin by creating two accounts named `A` and `B`, with the following command:

```
db.accounts.save({name: "A", balance: 1000, pendingTransactions: []})
db.accounts.save({name: "B", balance: 1000, pendingTransactions: []})
```

To verify that these operations succeeded, use `find()` (page 820):

```
db.accounts.find()
```

`mongo` (page 908) will return two *documents* that resemble the following:

```
{ "_id" : ObjectId("4d7bc66cb8a04f512696151f"), "name" : "A", "balance" : 1000, "pendingTransactions"
{ "_id" : ObjectId("4d7bc67bb8a04f5126961520"), "name" : "B", "balance" : 1000, "pendingTransactions"
```

Transaction Description

Set Transaction State to Initial

Create the `transaction` collection by inserting the following document. The transaction document holds the `source` and `destination`, which refer to the `name` fields of the `accounts` collection, as well as the `value` field that represents the amount of data change to the `balance` field. Finally, the `state` field reflects the current state of the transaction.

```
db.transactions.save({source: "A", destination: "B", value: 100, state: "initial"})
```

To verify that these operations succeeded, use `find()` (page 820):

```
db.transactions.find()
```

This will return a document similar to the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "source" : "A", "destination" : "B", "value" : 100,
```

Switch Transaction State to Pending

Before modifying either records in the `accounts` collection, set the transaction state to `pending` from `initial`.

Set the local variable `t` in your shell session, to the transaction document using `findOne()` (page 825):

```
t = db.transactions.findOne({state: "initial"})
```

After assigning this variable `t`, the shell will return the value of `t`, you will see the following output:

```
{
     "_id" : ObjectId("4d7bc7a8b8a04f5126961522"),
     "source" : "A",
     "destination" : "B",
     "value" : 100,
     "state" : "initial"
}
```

Use `update()` (page 842) to change the value of `state` to `pending`:

```
db.transactions.update({_id: t._id}, {$set: {state: "pending"}})
db.transactions.find()
```

The `find()` (page 820) operation will return the contents of the `transactions` collection, which should resemble the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "source" : "A", "destination" : "B", "value" : 100, "
```

Apply Transaction to Both Accounts

Continue by applying the transaction to both accounts. The `update()` (page 842) query will prevent you from applying the transaction *if* the transaction is *not* already pending. Use the following `update()` (page 842) operation:

```
db.accounts.update({name: t.source, pendingTransactions: {$ne: t._id}}, {$inc: {balance: -t.value}, $
db.accounts.update({name: t.destination, pendingTransactions: {$ne: t._id}}, {$inc: {balance: t.value
db.accounts.find()
```

The `find()` (page 820) operation will return the contents of the `accounts` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc97fb8a04f5126961523"), "balance" : 900, "name" : "A", "pendingTransactions"
{ "_id" : ObjectId("4d7bc984b8a04f5126961524"), "balance" : 1100, "name" : "B", "pendingTransactions"
```

Set Transaction State to Committed

Use the following `update()` (page 842) operation to set the transaction's state to `committed`:

```
db.transactions.update({_id: t._id}, {$set: {state: "committed"}})
db.transactions.find()
```

The `find()` (page 820) operation will return the contents of the `transactions` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "destination" : "B", "source" : "A", "state" : "comm
```

Remove Pending Transaction

Use the following `update()` (page 842) operation to set remove the pending transaction from the *documents* in the `accounts` collection:

```
db.accounts.update({name: t.source}, {$pull: {pendingTransactions: t._id}})
db.accounts.update({name: t.destination}, {$pull: {pendingTransactions: t._id}})
db.accounts.find()
```

The `find()` (page 820) operation will return the contents of the `accounts` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc97fb8a04f5126961523"), "balance" : 900, "name" : "A", "pendingTransactions"
{ "_id" : ObjectId("4d7bc984b8a04f5126961524"), "balance" : 1100, "name" : "B", "pendingTransactions"
```

Set Transaction State to Done

Complete the transaction by setting the `state` of the transaction *document* to `done`:

```
db.transactions.update({_id: t._id}, {$set: {state: "done"}})
db.transactions.find()
```

The `find()` (page 820) operation will return the contents of the `transactions` collection, which should now resemble the following:

```
{ "_id" : ObjectId("4d7bc7a8b8a04f5126961522"), "destination" : "B", "source" : "A", "state" : "done"
```

Recovering from Failure Scenarios

The most important part of the transaction procedure is not, the prototypical example above, but rather the possibility for recovering from the various failure scenarios when transactions do not complete as intended. This section will provide an overview of possible failures and provide methods to recover from these kinds of events.

There are two classes of failures:

- all failures that occur after the first step (i.e. "*setting the transaction set to initial* (page 446)") but before the third step (i.e. "*applying the transaction to both accounts* (page 447).")

  To recover, applications should get a list of transactions in the `pending` state and resume from the second step (i.e. "*switching the transaction state to pending* (page 447).")

- all failures that occur after the third step (i.e. "*applying the transaction to both accounts* (page 447)") but before the fifth step (i.e. "*setting the transaction state to done* (page 448).")

  To recover, application should get a list of transactions in the `committed` state and resume from the fourth step (i.e. "*remove the pending transaction* (page 448).")

Thus, the application will always be able to resume the transaction and eventually arrive at a consistent state. Run the following recovery operations every time the application starts to catch any unfinished transactions. You may also wish run the recovery operation at regular intervals to ensure that your data remains consistent.

The time required to reach a consistent state depends, on how long the application needs to recover each transaction.

Rollback

In some cases you may need to "rollback" or undo a transaction when the application needs to "cancel" the transaction, or because it can never recover as in cases where one of the accounts doesn't exist, or stops existing during the transaction.

There are two possible rollback operations:

1. After you *apply the transaction* (page 447) (i.e. the third step,) you have fully committed the transaction and you should not roll back the transaction. Instead, create a new transaction and switch the values in the source and destination fields.
2. After you *create the transaction* (page 446) (i.e. the first step,) but before you *apply the transaction* (page 447) (i.e the third step,) use the following process:

Set Transaction State to Canceling Begin by setting the transaction's state to `canceling` using the following `update()` (page 842) operation:

```
db.transactions.update({_id: t._id}, {$set: {state: "canceling"}})
```

Undo the Transaction Use the following sequence of operations to undo the transaction operation from both accounts:

```
db.accounts.update({name: t.source, pendingTransactions: t._id}, {$inc: {balance: t.value}, $pull: {p
db.accounts.update({name: t.destination, pendingTransactions: t._id}, {$inc: {balance: -t.value}, $pu
db.accounts.find()
```

The `find()` (page 820) operation will return the contents of the `accounts` collection, which should resemble the following:

```
{ "_id" : ObjectId("4d7bc97fb8a04f5126961523"), "balance" : 1000, "name" : "A", "pendingTransactions"
{ "_id" : ObjectId("4d7bc984b8a04f5126961524"), "balance" : 1000, "name" : "B", "pendingTransactions"
```

Set Transaction State to Canceled Finally, use the following `update()` (page 842) operation to set the transaction's state to `canceled`:

Step 3: set the transaction's state to "canceled":

```
db.transactions.update({_id: t._id}, {$set: {state: "canceled"}})
```

Multiple Applications

Transactions exist, in part, so that several applications can create and run operations concurrently without causing data inconsistency or conflicts. As a result, it is crucial that only one 1 application can handle a given transaction at any point in time.

Consider the following example, with a single transaction (i.e. `T1`) and two applications (i.e. `A1` and `A2`). If both applications begin processing the transaction which is still in the `initial` state (i.e. *step 1* (page 446)), then:

- `A1` can apply the entire whole transaction before `A2` starts.
- `A2` will then apply `T1` for the second time, because the transaction does not appear as pending in the `accounts` documents.

To handle multiple applications, create a marker in the transaction document itself to identify the application that is handling the transaction. Use `findAndModify()` (page 822) method to modify the transaction:

```
t = db.transactions.findAndModify({query: {state: "initial", application: {$exists: 0}},
                                   update: {$set: {state: "pending", application: "A1"}},
                                   new: true})
```

When you modify and reassign the local shell variable `t`, the `mongo` (page 908) shell will return the `t` object, which should resemble the following:

```
{
     "_id" : ObjectId("4d7be8af2c10315c0847fc85"),
     "application" : "A1",
     "destination" : "B",
     "source" : "A",
     "state" : "pending",
     "value" : 150
}
```

Amend the transaction operations to ensure that only applications that match the identifier in the value of the `application` field before applying the transaction.

If the application `A1` fails during transaction execution, you can use the *recovery procedures* (page 448), but applications should ensure that they "owns" the transaction before applying the transaction. For example to resume pending jobs, use a query that resembles the following:

```
db.transactions.find({application: "A1", state: "pending"})
```

This will (or may) return a document from the `transactions` document that resembles the following:

```
{ "_id" : ObjectId("4d7be8af2c10315c0847fc85"), "application" : "A1", "destination" : "B", "source"
```

36.1.4 Using Two-Phase Commits in Production Applications

The example transaction above is intentionally simple. For example, it assumes that:

- it is always possible roll back operations an account.
- account balances can hold negative values.

Production implementations would likely be more complex. Typically accounts need to information about current balance, pending credits, pending debits. Then:

- when your application *switches the transaction state to pending* (page 447) (i.e. step 2) it would also make sure that the accounts has sufficient funds for the transaction. During this update operation, the application would also modify the values of the credits and debits as well as adding the transaction as pending.
- when your application *removes the pending transaction* (page 447) (i.e. step 4) the application would apply the transaction on balance, modify the credits and debits as well as removing the transaction from the `pending` field., all in one update.

Because all of the changes in the above two operations occur within a single `update()` (page 842) operation, these changes are all atomic.

Additionally, for most important transactions, ensure that:

- the database interface (i.e. client library or *driver*) has a reasonable *write concern* configured to ensure that operations return a response on the success or failure of a write operation.
- your `mongod` (page 897) instance has *journaling* enabled to ensure that your data is always in a recoverable state, in the event of an unclean `mongod` (page 897) shutdown.

36.2 Create Tailable Cursor

36.2.1 Overview

By default, MongoDB will automatically close a cursor when the client has exhausted all results in the cursor. However, for *capped collections* (page 440) you may use a *Tailable Cursor* that remains open after the client exhausts the results in the initial cursor. Tailable cursors are conceptually equivalent to the `tail` Unix command with the `-f` option (i.e. with "follow" mode.) After clients insert new additional documents into a capped collection, the tailable cursor will continue to retrieve documents.

Use tailable cursors on capped collections with high numbers of write operations for which an index would be too expensive. For instance, MongoDB *replication* (page 279) uses tailable cursors to tail the primary's *oplog*.

Note: If your query is on an indexed field, do not use tailable cursors, but instead, use a regular cursor. Keep track of the last value of the indexed field returned by the query. To retrieve the newly added documents, query the collection again using the last value of the indexed field in the query criteria, as in the following example:

```
db.<collection>.find( { indexedField: { $gt: <lastvalue> } } )
```

Consider the following behaviors related to tailable cursors:

- Tailable cursors do not use indexes and return documents in *natural order*.
- Because tailable cursors do not use indexes, the initial scan for the query may be expensive; but, after initially exhausting the cursor, subsequent retrievals of the newly added documents are inexpensive.
- Tailable cursors may become *dead*, or invalid, if either:
  - the query returns no match.
  - the cursor returns the document at the "end" of the collection and then the application deletes those document.

  A *dead* cursor has an id of `0`.

See your *driver documentation* (page 435) for the driver-specific method to specify the tailable cursor. For more information on the details of specifying a tailable cursor, see MongoDB wire protocol documentation.

36.2.2 C++ Example

The `tail` function uses a tailable cursor to output the results from a query to a capped collection:

- The function handles the case of the dead cursor by having the query be inside a loop.
- To periodically check for new data, the `cursor->more()` statement is also inside a loop.

```
#include "client/dbclient.h"

using namespace mongo;

/*
 * Example of a tailable cursor.
 * The function "tails" the capped collection (ns) and output elements as they are added.
 * The function also handles the possibility of a dead cursor by tracking the field 'insertDate'.
 * New documents are added with increasing values of 'insertDate'.
 */

void tail(DBClientBase& conn, const char *ns) {
```

```
    BSONElement lastValue = minKey.firstElement();

    Query query = Query().hint( BSON( "$natural" << 1 ) );

    while ( 1 ) {
        auto_ptr<DBClientCursor> c =
            conn.query(ns, query, 0, 0, 0,
                       QueryOption_CursorTailable | QueryOption_AwaitData );

        while ( 1 ) {
            if ( !c->more() ) {

                if ( c->isDead() ) {
                    break;
                }

                continue;
            }

            BSONObj o = c->next();
            lastValue = o["insertDate"];
            cout << o.toString() << endl;
        }

        query = QUERY( "insertDate" << GT << lastValue ).hint( BSON( "$natural" << 1 ) );
    }
}
```

The `tail` function performs the following actions:

- Initialize the `lastValue` variable, which tracks the last accessed value. The function will use the `lastValue` if the cursor becomes *invalid* and `tail` needs to restart the query. Use `hint()` (page 806) to ensure that the query uses the `$natural` (page 704) order.
- In an outer `while(1)` loop,
  - Query the capped collection and return a tailable cursor that blocks for several seconds waiting for new documents

    ```
    auto_ptr<DBClientCursor> c =
         conn.query(ns, query, 0, 0, 0,
                    QueryOption_CursorTailable | QueryOption_AwaitData );
    ```

    * Specify the capped collection using `ns` as an argument to the function.
    * Set the `QueryOption_CursorTailable` option to create a tailable cursor.
    * Set the `QueryOption_AwaitData` option so that the returned cursor blocks for a few seconds to wait for data.
  - In an inner `while (1)` loop, read the documents from the cursor:
    * If the cursor has no more documents and is not invalid, loop the inner `while` loop to recheck for more documents.
    * If the cursor has no more documents and is dead, break the inner `while` loop.
    * If the cursor has documents:
      · output the document,
      · update the `lastValue` value,

        - and loop the inner `while (1)` loop to recheck for more documents.
    - If the logic breaks out of the inner `while (1)` loop and the cursor is invalid:
        - Use the `lastValue` value to create a new query condition that matches documents added after the `lastValue`. Explicitly ensure `$natural` order with the `hint()` method:

          ```
          query = QUERY( "insertDate" << GT << lastValue ).hint( BSON( "$natural" << 1 ) );
          ```

        - Loop through the outer `while (1)` loop to re-query with the new query condition and repeat.

See Also:

Detailed blog post on tailable cursor

36.3 Isolate Sequence of Operations

36.3.1 Overview

Write operations are atomic on the level of a single document: no single write operation can atomically affect more than one document or more than one collection.

When a single write operation modifies multiple documents, the operation as a whole is not atomic, and other operations may interleave. The modification of a single document, or record, is always atomic, even if the write operation modifies multiple sub-document *within* the single record.

No other operations are atomic; however, you can *isolate* a single write operation that affects multiple documents using the *isolation operator* (page 699).

This document describes one method of updating documents *only* if the local copy of the document reflects the current state of the document in the database. In addition the following methods provide a way to manage isolated sequences of operations:

- the `findAndModify()` (page 822) provides an isolated query and modify operation.
- *Perform Two Phase Commits* (page 445)
- Create a *unique index* (page 246), to ensure that a key doesn't exist when you insert it.

36.3.2 Update if Current

In this pattern, you will:

- query for a document,
- modify the fields in that document
- and update the fields of a document *only if* the fields have not changed in the collection since the query.

Consider the following example in JavaScript which attempts to update the `qty` field of a document in the `products` collection:

```
1 var myCollection = db.products;
2 var myDocument = myCollection.findOne( { sku: 'abc123' } );
3
4 if (myDocument) {
5
6    var oldQty = myDocument.qty;
7
```

```
8     if (myDocument.qty < 10) {
9         myDocument.qty *= 4;
10    } else if ( myDocument.qty < 20 ) {
11        myDocument.qty *= 3;
12    } else {
13        myDocument.qty *= 2;
14    }
15
16    myCollection.update(
17       {
18         _id: myDocument._id,
19         qty: oldQty
20       },
21       {
22         $set: { qty: myDocument.qty }
23       }
24    )
25
26    var err = db.getLastErrorObj();
27
28    if ( err && err.code ) {
29        print("unexpected error updating document: " + tojson( err ));
30    } else if ( err.n == 0 ) {
31        print("No update: no matching document for { _id: " + myDocument._id + ", qty: " + oldQty + "
32    }
33
34 }
```

Your application may require some modifications of this pattern, such as:

- Use the entire document as the query in lines 18 and 19, to generalize the operation and guarantee that the original document was not modified, rather than ensuring that as single field was not changed.
- Add a version variable to the document that applications increment upon each update operation to the documents. Use this version variable in the query expression. You must be able to ensure that *all* clients that connect to your database obey this constraint.
- Use `$set` (page 716) in the update expression to modify only your fields and prevent overriding other fields.
- Use one of the methods described in *Create an Auto-Incrementing Sequence Field* (page 454).

36.4 Create an Auto-Incrementing Sequence Field

36.4.1 Synopsis

MongoDB reserves the `_id` field in the top level of all documents as a primary key. `_id` must be unique, and always has an index with a *unique constraint* (page 246). However, except for the unique constraint you can use any value for the `_id` field in your collections. This tutorial describes two methods for creating an incrementing sequence number for the `_id` field using the following:

- *A Counters Collection* (page 455)
- *Optimistic Loop* (page 456)

Warning: Generally in MongoDB, you would not use an auto-increment pattern for the `_id` field, or any field, because it does not scale for databases with larger numbers of documents. Typically the default value *ObjectId* is more ideal for the `_id`.

A Counters Collection

Use a separate `counters` collection tracks the *last* number sequence used. The `_id` field contains the sequence name and the `seq` contains the last value of the sequence.

1. Insert into the `counters` collection, the initial value for the `userid`:

```
db.counters.insert(
   {
      _id: "userid",
      seq: 0
   }
)
```

2. Create a `getNextSequence` function that accepts a `name` of the sequence. The function uses the `findAndModify()` (page 822) method to atomically increment the `seq` value and return this new value:

```
function getNextSequence(name) {
   var ret = db.counters.findAndModify(
          {
            query: { _id: name },
            update: { $inc: { seq: 1 } },
            new: true
          }
   );

   return ret.seq;
}
```

3. Use this `getNextSequence()` function during `insert()` (page 830).

```
db.users.insert(
   {
     _id: getNextSequence("userid"),
     name: "Sarah C."
   }
)

db.users.insert(
   {
     _id: getNextSequence("userid"),
     name: "Bob D."
   }
)
```

You can verify the results with `find()` (page 820):

```
db.users.find()
```

The `_id` fields contain incrementing sequence values:

```
{
  _id : 1,
  name : "Sarah C."
```

```
}
{
  _id : 2,
  name : "Bob D."
}
```

Note: When `findAndModify()` (page 822) includes the `upsert: true` option **and** the query field(s) is not uniquely indexed, the method could insert a document multiple times in certain circumstances. For instance, if multiple clients each invoke the method with the same query condition and these methods complete the find phase before any of methods perform the modify phase, these methods could insert the same document.

In the `counters` collection example, the query field is the `_id` field, which always has a unique index. Consider that the `findAndModify()` (page 822) includes the `upsert: true` option, as in the following modified example:

```
function getNextSequence(name) {
   var ret = db.counters.findAndModify(
          {
            query: { _id: name },
            update: { $inc: { seq: 1 } },
            new: true,
            upsert: true
          }
   );

   return ret.seq;
}
```

If multiple clients were to invoke the `getNextSequence()` method with the same `name` parameter, then the methods would observe one of the following behaviors:

- Exactly one `findAndModify()` (page 822) would successfully insert a new document.
- Zero or more `findAndModify()` (page 822) methods would update the newly inserted document.
- Zero or more `findAndModify()` (page 822) methods would fail when they attempted to insert a duplicate.

If the method fails due to a unique index constraint violation, retry the method. Absent a delete of the document, the retry should not fail.

Optimistic Loop

In this pattern, an *Optimistic Loop* calculates the incremented `_id` value and attempts to insert a document with the calculated `_id` value. If the insert is successful, the loop ends. Otherwise, the loop will iterate through possible `_id` values until the insert is successful.

1. Create a function named `insertDocument` that performs the "insert if not present" loop. The function wraps the `insert()` (page 830) method and takes a `doc` and a `targetCollection` arguments.

   ```
   function insertDocument(doc, targetCollection) {

       while (1) {

           var cursor = targetCollection.find( {}, { _id: 1 } ).sort( { _id: -1 } ).limit(1);

           var seq = cursor.hasNext() ? cursor.next()._id + 1 : 1;

           doc._id = seq;
   ```

```
            targetCollection.insert(doc);

            var err = db.getLastErrorObj();

            if( err && err.code ) {
                if( err.code == 11000 /* dup key */ )
                    continue;
                else
                    print( "unexpected error inserting data: " + tojson( err ) );
            }

            break;
        }
    }
```

The `while (1)` loop performs the following actions:

- Queries the `targetCollection` for the document with the maximum `_id` value.
- Determines the next sequence value for `_id` by:
  - adding `1` to the returned `_id` value if the returned cursor points to a document.
  - otherwise: it sets the next sequence value to `1` if the returned cursor points to no document.
- For the `doc` to insert, set its `_id` field to the calculated sequence value `seq`.
- Insert the `doc` into the `targetCollection`.
- If the insert operation errors with duplicate key, repeat the loop. Otherwise, if the insert operation encounters some other error or if the operation succeeds, break out of the loop.

2. Use the `insertDocument()` function to perform an insert:

```
var myCollection = db.users2;

insertDocument(
   {
     name: "Grace H."
   },
   myCollection
);

insertDocument(
   {
     name: "Ted R."
   },
   myCollection
)
```

You can verify the results with `find()` (page 820):

```
db.users2.find()
```

The `_id` fields contain incrementing sequence values:

```
{
  _id: 1,
  name: "Grace H."
}
{
```

```
    _id : 2,
    "name" : "Ted R."
}
```

The `while` loop may iterate many times in collections with larger insert volumes.

36.5 Expire Data from Collections by Setting TTL

New in version 2.2. This document provides an introductions to MongoDB's "*time to live*" or "*TTL*" collection feature. Implemented as a special index type, TTL collections make it possible to store data in MongoDB and have the `mongod` (page 897) automatically remove data after a specified period of time. This is ideal for some types of information like machine generated event data, logs, and session information that only need to persist in a database for a limited period of time.

36.5.1 Background

Collections expire by way of a special index that keeps track of insertion time in conjunction with a background thread in `mongod` (page 897) that regularly removes expired *documents* from the collection. You can use this feature to expire data from *replica sets* and *sharded clusters*.

Use the `expireAfterSeconds` option to the `ensureIndex` (page 819) method in conjunction with a TTL value in seconds to create an expiring collection. TTL collections set the `usePowerOf2Sizes` (page 744) collection flag, which means MongoDB must allocate more disk space relative to data size. This approach helps mitigate the possibility of storage fragmentation caused by frequent delete operations and leads to more predictable storage use patterns.

Note: When the TTL thread is active, you will see a *delete* (page 175) operation in the output of `db.currentOp()` (page 846) or in the data collected by the *database profiler* (page 616).

36.5.2 Constraints

Consider the following limitations:

- the indexed field must be a date *BSON type*. If the field does not have a date type, the data will not expire.
- you cannot create this index on the `_id` field, or a field that already has an index.
- the TTL index may not be compound (may not have multiple fields).
- if the field holds an array, and there are multiple date-typed data in the index, the document will expire when the *lowest* (i.e. earliest) matches the expiration threshold.
- you cannot use a TTL index on a capped collection, because MongoDB cannot remove documents from a capped collection.

Note: TTL indexes expire data by removing documents in a background task that runs once a minute. As a result, the TTL index provides no guarantees that expired documents will not exist in the collection. Consider that:

- Documents may remain in a collection *after* they expire and before the background process runs.
- The duration of the removal operations depend on the workload of your `mongod` (page 897) instance.

36.5.3 Enabling a TTL for a Collection

To set a TTL on the collection "`log.events`" for one hour use the following command at the `mongo` (page 908) shell:

```
db.log.events.ensureIndex( { "status": 1 }, { expireAfterSeconds: 3600 } )
```

The `status` field *must* hold date/time information. MongoDB will automatically delete documents from this collection once the value of `status` is one or more hours old.

36.5.4 Replication

The TTL background thread *only* runs on *primary* members of *replica sets*. *Secondaries* members will replicate deletion operations from the primaries.

Part X

Using the mongo Shell

The mongo (page 908) shell is an interactive JavaScript shell for MongoDB, and is part of all MongoDB distributions. This section provides an introduction to the shell, and outlines key functions, operations, and use of the mongo (page 908) shell.

Most examples in the *MongoDB Manual* (page 1) use the mongo (page 908) shell; however, many *drivers* (page 435) provide similar interfaces to MongoDB.

CHAPTER 37

Getting Started with the mongo Shell

This document provides a basic introduction to using the mongo (page 908) shell. See *Installing MongoDB* (page 3) for instructions on installing MongoDB for your system.

37.1 Start the mongo Shell

To start the mongo (page 908) shell and connect to your *MongoDB* (page 897) instance running on **localhost** with **default port**:

1. Go to your <mongodb installation dir>:

   ```
   cd <mongodb installation dir>
   ```

2. Type ./bin/mongo to start mongo (page 908):

   ```
   ./bin/mongo
   ```

   If you have added the <mongodb installation dir>/bin to the PATH environment variable, you can just type mongo instead of ./bin/mongo.

3. To display the database you are using, type db:

   ```
   db
   ```

   The command should return test, which is the default database. To switch databases, issue the use <db> command, as in the following example:

   ```
   use <database>
   ```

   To list the available databases, use the command show dbs. See also *How can I access to different databases temporarily?* (page 649) to access a different database from the current database without switching your current database context (i.e. db..)

To start the mongo (page 908) shell with other options, see *examples of starting up mongo* (page 911) and *mongo reference* (page 908) which provides details on the available options.

Note: When starting, mongo (page 908) checks the user's HOME (page 910) directory for a JavaScript file named *.mongorc.js* (page 910). If found, mongo (page 908) interprets the content of .mongorc.js before displaying the prompt for the first time. If you use the shell to evaluate a JavaScript file or expression, either by using the --eval

(page 909) option on the command line or by specifying *a .js file to mongo* (page 909), `mongo` (page 908) will read the `.mongorc.js` file *after* the JavaScript has finished processing.

37.2 Executing Queries

From the `mongo` (page 908) shell, you can use the *shell methods* (page 889) to run queries, as in the following example:

```
db.<collection>.find()
```

- The `db` refers to the current database.
- The `<collection>` is the name of the collection to query. See *Collection Help* (page 474) to list the available collections.

  If the `mongo` (page 908) shell does not accept the name of the collection, for instance if the name contains a space or starts with a number, you can use an alternate syntax to refer to the collection, as in the following:

  ```
  db["3test"].find()

  db.getCollection("3test").find()
  ```

- The `find()` (page 820) method is the JavaScript method to retrieve documents from `<collection>`. The `find()` (page 820) method returns a *cursor* to the results; however, in the `mongo` (page 908) shell, if the returned cursor is not assigned to a variable, then the cursor is automatically iterated up to 20 times to print up to the first 20 documents that match the query. The `mongo` (page 908) shell will prompt `Type it` to iterate another 20 times.

  You can set the `DBQuery.shellBatchSize` attribute to change the number of iteration from the default value `20`, as in the following example which sets it to `10`:

  ```
  DBQuery.shellBatchSize = 10;
  ```

  For more information and examples on cursor handling in the `mongo` (page 908) shell, see *Cursors* (page 119).

  See also *Cursor Help* (page 474) for list of cursor help in the `mongo` (page 908) shell.

For more documentation of basic MongoDB operations in the `mongo` (page 908) shell, see:

- *Getting Started with MongoDB Development* (page 20)
- *mongo Shell Quick Reference* (page 479)
- *Create* (page 151)
- *Read* (page 159)
- *Update* (page 169)
- *Delete* (page 175)
- *Indexing Operations* (page 251)
- *Read Operations* (page 111)
- *Write Operations* (page 123)

37.3 Print

The mongo (page 908) shell automatically prints the results of the find() (page 820) method if the returned cursor is not assigned to a variable. To format the result, you can add the .pretty() to the operation, as in the following:

```
db.<collection>.find().pretty()
```

In addition, you can use the following explicit print methods in the mongo (page 908) shell:

- print() to print without formatting
- print(tojson(<obj>)) to print with *JSON* formatting and equivalent to printjson()
- printjson() to print with *JSON* formatting and equivalent to print(tojson(<obj>))

37.4 Use a Custom Prompt

You may modify the content of the prompt by creating the variable prompt in the shell. The prompt variable can hold strings as well as any arbitrary JavaScript. If prompt holds a function that returns a string, mongo (page 908) can display dynamic information in each prompt. Consider the following examples:

Example

Create a prompt with the number of commands issued in the current session, define the following variables:

```
cmdCount = 1;
prompt = function() {
             return (cmdCount++) + "> ";
         }
```

The prompt would then resemble the following:

```
1> db.collection.find()
2> show collections
3>
```

Example

To create a mongo (page 908) shell prompt in the form of <database>@<hostnane>$ define the following variables:

```
host = db.serverStatus().host;

prompt = function() {
             return db+"@"+host+"$ ";
         }
```

The prompt would then resemble the following:

```
<database>@<hostname>$ use records
switched to db records
records@<hostname>$
```

Example

To create a mongo (page 908) shell prompt that contains the system up time *and* the number of documents in the current database, define the following prompt variable:

```
prompt = function() {
             return "Uptime:"+db.serverStatus().uptime+" Documents:"+db.stats().objects+" > ";
         }
```

The prompt would then resemble the following:

```
Uptime:5897 Documents:6 > db.people.save({name : "James"});
Uptime:5948 Documents:7 >
```

37.5 Use an External Editor in the mongo Shell

New in version 2.2. In the mongo (page 908) shell you can use the `edit` operation to edit a function or variable in an external editor. The `edit` operation uses the value of your environments `EDITOR` variable.

At your system prompt you can define the `EDITOR` variable and start mongo (page 908) with the following two operations:

```
export EDITOR=vim
mongo
```

Then, consider the following example shell session:

```
MongoDB shell version: 2.2.0
> function f() {}
> edit f
> f
function f() {
    print("this really works");
}
> f()
this really works
> o = {}
{ }
> edit o
> o
{ "soDoes" : "this" }
>
```

Note: As mongo (page 908) shell interprets code edited in an external editor, it may modify code in functions, depending on the JavaScript compiler. For mongo (page 908) may convert `1+1` to `2` or remove comments. The actual changes affect only the appearance of the code and will vary based on the version of JavaScript used but will not affect the semantics of the code.

37.6 Exit the Shell

To exit the shell, type `quit()` or use the `<Ctrl-c>` shortcut.

CHAPTER 38

Data Types in the mongo Shell

MongoDB *BSON* provide support for additional data types than *JSON*. *Drivers* (page 435) provide native support for these data types in host languages and the mongo (page 908) shell also provides several helper classes to support the use of these data types in the mongo (page 908) JavaScript shell. See *MongoDB Extended JSON* (page 1024) for additional information.

38.1 Date

The mongo (page 908) shell provides various options to return the date, either as a string or as an object:

- Date() method which returns the current date as a string.
- Date() constructor which returns an ISODate object when used with the new operator.
- ISODate() constructor which returns an ISODate object when used with *or* without the new operator.

Consider the following examples:

- To return the date as a string, use the Date() method, as in the following example:

  ```
  var myDateString = Date();
  ```

  - To print the value of the variable, type the variable name in the shell, as in the following:

    ```
    myDateString
    ```

    The result is the value of myDateString:

    ```
    Wed Dec 19 2012 01:03:25 GMT-0500 (EST)
    ```

  - To verify the type, use the typeof operator, as in the following:

    ```
    typeof myDateString
    ```

    The operation returns string.

- To get the date as an ISODate object, instantiate a new instance using the Date() constructor with the new operator, as in the following example:

  ```
  var myDateObject = new Date();
  ```

  - To print the value of the variable, type the variable name in the shell, as in the following:

    ```
    myDateObject
    ```

    The result is the value of `myDateObject`:

    ```
    ISODate("2012-12-19T06:01:17.171Z")
    ```

  - To verify the type, use the `typeof` operator, as in the following:

    ```
    typeof myDateObject
    ```

    The operation returns `object`.

- To get the date as an `ISODate` object, instantiate a new instance using the `ISODate()` constructor *without* the `new` operator, as in the following example:

  ```
  var myDateObject2 = ISODate();
  ```

  You can use the `new` operator with the `ISODate()` constructor as well.

  - To print the value of the variable, type the variable name in the shell, as in the following:

    ```
    myDateObject2
    ```

    The result is the value of `myDateObject2`:

    ```
    ISODate("2012-12-19T06:15:33.035Z")
    ```

  - To verify the type, use the `typeof` operator, as in the following:

    ```
    typeof myDateObject2
    ```

    The operation returns `object`.

38.2 ObjectId

The `mongo` (page 908) shell provides the `ObjectId()` wrapper class around *ObjectId* data types. To generate a new ObjectId, use the following operation in the `mongo` (page 908) shell:

```
new ObjectId
```

See Also:

ObjectId (page 142) for full documentation of ObjectIds in MongoDB.

38.3 NumberLong

By default, the `mongo` (page 908) shell treats all numbers as floating-point values. The `mongo` (page 908) shell provides the `NumberLong()` class to handle 64-bit integers.

The `NumberLong()` constructor accepts the long as a string:

```
NumberLong("2090845886852")
```

The following examples use the `NumberLong()` class to write to the collection:

```
db.collection.insert( { _id: 10, calc: NumberLong("2090845886852") } )
db.collection.update( { _id: 10 },
                      { $set:  { calc: NumberLong("2555555000000") } } )
db.collection.update( { _id: 10 },
                      { $inc: { calc: NumberLong(5) } } )
```

Retrieve the document to verify:

```
db.collection.findOne( { _id: 10 } )
```

In the returned document, the `calc` field contains a `NumberLong` object:

```
{ "_id" : 10, "calc" : NumberLong("2555555000005") }
```

If you `increment` (page 699) the field that contains a `NumberLong` object by a **float**, the data type changes to a floating point value, as in the following example:

1. Use `$inc` (page 699) to increment the `calc` field by `5`, which the `mongo` (page 908) shell treats as a float:

   ```
   db.collection.update( { _id: 10 },
                         { $inc: { calc: 5 } } )
   ```

2. Retrieve the updated document:

   ```
   db.collection.findOne( { _id: 10 } )
   ```

   In the updated document, the `calc` field contains a floating point value:

   ```
   { "_id" : 10, "calc" : 2555555000010 }
   ```

CHAPTER 39

Access the mongo Shell Help Information

In addition to the documentation in the *MongoDB Manual* (page 1), the mongo (page 908) shell provides some additional information in its "online" help system. This document provides an overview of accessing this help information.

See Also:

- *mongo Manual Page* (page 908)
- *Using the mongo Shell* (page 463) (*MongoDB Manual* (page 1) section on the shell.)
- *mongo Shell Quick Reference* (page 479).

39.1 Command Line Help

To see the list of options and help for starting the mongo (page 908) shell, use the *--help* (page 909) option from the command line:

```
mongo --help
```

39.2 Shell Help

To see the list of help, in the mongo (page 908) shell, type help:

```
help
```

39.3 Database Help

- To see the list of databases on the server, use the show dbs command:

  ```
  show dbs
  ```

- To see the list of help for methods you can use on the db object, call the db.help() (page 850) method:

```
db.help()
```

- To see the implementation of a method in the shell, type the `db.<method name>` without the parenthesis (`()`), as in the following example which will return the implementation of the method `db.addUser()` (page 814):

  ```
  db.addUser
  ```

39.4 Collection Help

- To see the list of collections in the current database, use the `show collections` command:

  ```
  show collections
  ```

- To see the help for methods available on the collection objects (e.g. `db.<collection>`), use the `db.<collection>.help()` method:

  ```
  db.collection.help()
  ```

  `<collection>` can be the name of a collection that exists, although you may specify a collection that doesn't exist.

- To see the collection method implementation, type the `db.<collection>.<method>` name without the parenthesis (`()`), as in the following example which will return the implementation of the `save()` (page 840) method:

  ```
  db.collection.save
  ```

39.5 Cursor Help

When you perform *read operations* (page 111) with the `find()` (page 820) method in the `mongo` (page 908) shell, you can use various cursor methods to modify the `find()` (page 820) behavior and various JavaScript methods to handle the cursor returned from the `find()` (page 820) method.

- To list the available modifier and cursor handling methods, use the `db.collection.find().help()` command:

  ```
  db.collection.find().help()
  ```

  `<collection>` can be the name of a collection that exists, although you may specify a collection that doesn't exist.

- To see the implementation of the cursor method, type the `db.<collection>.find().<method>` name without the parenthesis (`()`), as in the following example which will return the implementation of the `toArray()` method:

  ```
  db.collection.find().toArray
  ```

Some useful methods for handling cursors are:

- `hasNext()` (page 806) which checks whether the cursor has more documents to return.
- `next()` (page 811) which returns the next document and advances the cursor position forward by one.
- `forEach(<function>)` (page 806) which iterates the whole cursor and applies the `<function>` to each document returned by the cursor. The `<function>` expects a single argument which corresponds to the document from each iteration.

For examples on iterating a cursor and retrieving the documents from the cursor, see *cursor handling* (page 119). See also *Cursor Methods* (page 890) for all available cursor methods.

39.6 Type Help

To get a list of the wrapper classes available in the `mongo` (page 908) shell, such as `BinData()`, type `help misc` in the `mongo` (page 908) shell:

```
help misc
```

CHAPTER 40

Write Scripts for the mongo Shell

You can write scripts for the mongo (page 908) shell in JavaScript that manipulate data in MongoDB or perform administrative operation. For more information about the mongo (page 908) shell see *Using the mongo Shell* (page 463), and see the *Running .js files via a mongo shell Instance on the Server* (page 439) section for more information about using these mongo (page 908) script.

This tutorial provides an introduction to writing JavaScript that uses the mongo (page 908) shell to access MongoDB.

40.1 Opening New Connections

From the mongo (page 908) shell or from a JavaScript file, you can instantiate database connections using the Mongo() (page 801) constructor:

```
new Mongo()
new Mongo(<host>)
new Mongo(<host:port>)
```

Consider the following example that instantiates a new connection to the MongoDB instance running on localhost on the default port and sets the global db variable to myDatabase using the getDB() (page 801) method:

```
conn = new Mongo();
db = conn.getDB("myDatabase");
```

Additionally, you can use the connect() method to connect to the MongoDB instance. The following example connects to the MongoDB instance that is running on localhost with the non-default port 27020 and set the global db variable:

```
db = connect("localhost:27020/myDatabase");
```

If you create new connections inside a *JavaScript file* (page 478):

- You **cannot** use use <dbname> inside the file to set the db global variable.
- To set the db global variable, use the getDB() (page 801) method or the connect() method. You can assign the database reference to a variable other than db.
- Additionally, inside the script, you would need to call db.getLastErrorObj() (page 849) or db.getLastError() (page 849) explicitly to wait for the result of *write operations* (page 123).

40.2 Scripting

From the command line, use mongo (page 908) to evaluate JavaScript.

40.2.1 --eval option

Use the *--eval* (page 909) option to mongo (page 908) to pass the shell a JavaScript fragment, as in the following:

```
mongo test --eval "printjson(db.getCollectionNames())"
```

This returns the output of db.getCollectionNames() (page 849) using the mongo (page 908) shell connected to the mongod (page 897) or mongos (page 905) instance running on port 27017 on the localhost interface.

40.2.2 evaluate a javascript file

You can specify a .js file to the mongo (page 908) shell, and mongo (page 908) will evaluate the javascript directly. consider the following example:

```
mongo localhost:27017/test myjsfile.js
```

This operation evaluates the myjsfile.js script in a mongo (page 908) shell that connects to the test *database* on the mongod (page 897) instance accessible via the localhost interface on port 27017.

Alternately, you can specify the mongodb connection parameters inside of the javascript file using the Mongo() constructor. See *Opening New Connections* (page 477) for more information.

CHAPTER 41

mongo Shell Quick Reference

41.1 mongo Shell Command History

You can retrieve previous commands issued in the mongo (page 908) shell with the up and down arrow keys. Command history is stored in `~/.dbshell` file. See *.dbshell* (page 909) for more information.

41.2 Command Line Options

The mongo (page 908) executable can be started with numerous options. See *mongo executable* (page 908) page for details on all available options.

The following table displays some common options for mongo (page 908):

Option	Description
--help (page 909)	Show command line options
--nodb (page 908)	Start mongo (page 908) shell without connecting to a database. To connect later, see *Opening New Connections* (page 477).
--shell (page 908)	Used in conjunction with a JavaScript file (i.e. *<file.js>* (page 909)) to continue in the mongo (page 908) shell after running the JavaScript file. See *JavaScript file* (page 478) for an example.

41.3 Command Helpers

The mongo (page 908) shell provides various help. The following table displays some common help methods and commands:

Help Methods and Commands	Description
`help`	Show help.
`db.help()`	Show help for database methods.
`db.<collection>.help()`	Show help on collection methods. The `<collection>` can be the name of an existing collection or a non-existing collection.
`show dbs`	Print a list of all databases on the server.
`use <db>`	Switch current database to `<db>`. The `mongo` (page 908) shell variable `db` is set to the current database.
`show collections`	Print a list of all collections for current database
`show users`	Print a list of users for current database.
`show profile`	Print the five most recent operations that took 1 millisecond or more. See documentation on the *database profiler* (page 616) for more information.

41.4 Basic Shell JavaScript Operations

The `mongo` (page 908) shell provides numerous *mongo Shell JavaScript Quick Reference* (page 889) methods for database operations.

In the `mongo` (page 908) shell, `db` is the variable that references the current database. The variable is automatically set to the default database `test` or is set when you use the `use <db>` to switch current database.

The following table displays some common JavaScript operations:

JavaScript Database Operations	Description
`db.auth()` (page 814)	If running in secure mode, authenticate the user.

`coll = db.<collection>`	Set a specific collection in the current database to a variable `coll`, as in the following example:
	`coll = db.myCollection;`
	You can perform operations on the `myCollection` using the variable, as in the following example:
	`coll.find();`

`db.collection.find()` (page 820)	Find all documents in the collection and returns a cursor. See the *Read* (page 159) and *Read Operations* (page 111) for more information and examples. See *Cursors* (page 119) for additional information on cursor handling in the `mongo` (page 908) shell.
`db.collection.insert()` (page 830)	Insert a new document into the collection.
`db.collection.update()` (page 842)	Update an existing document in the collection. See *Update* (page 169) for more information.
`db.collection.save()` (page 840)	Insert either a new document or update an existing document in the collection. See *Update* (page 169) for more information.
`db.collection.remove()` (page 838)	Delete documents from the collection. See *Delete* (page 175) for more information.
`db.collection.drop()` (page 818)	Drops or removes completely the collection.
`db.collection.ensureIndex()` (page 819)	Create a new index on the collection if the index does not exist; otherwise, the operation has no effect.
`db.getSiblingDB()` (page 850) or `db.getSisterDB()`	Return a reference to another database using this same connection without explicitly switching the current database. This allows for cross database queries. See *How can I access to different databases temporarily?* (page 649) for more information.

For more information on performing operations in the shell, see:

- *Create* (page 151)
- *Read* (page 159)
- *Update* (page 169)
- *Delete* (page 175)
- *Indexing Operations* (page 251)
- *Read Operations* (page 111)
- *Write Operations* (page 123)
- *mongo Shell JavaScript Quick Reference* (page 889)

41.5 Keyboard Shortcuts

Changed in version 2.2. The `mongo` (page 908) shell provides most keyboard shortcuts similar to those found in the `bash` shell or in Emacs. For some functions `mongo` (page 908) provides multiple key bindings, to accommodate several familiar paradigms.

The following table enumerates the keystrokes supported by the `mongo` (page 908) shell:

Keystroke	Function
Up-arrow	previous-history
Down-arrow	next-history
Home	beginning-of-line
End	end-of-line
Tab	autocomplete
Left-arrow	backward-character
Right-arrow	forward-character
Ctrl-left-arrow	backward-word
Ctrl-right-arrow	forward-word
Meta-left-arrow	backward-word
Meta-right-arrow	forward-word
Ctrl-A	beginning-of-line
Ctrl-B	backward-char
Ctrl-C	exit-shell
Ctrl-D	delete-char (or exit shell)
Ctrl-E	end-of-line
Ctrl-F	forward-char
Ctrl-G	abort
Ctrl-J	accept-line
Ctrl-K	kill-line
Ctrl-L	clear-screen
Ctrl-M	accept-line
Ctrl-N	next-history
Ctrl-P	previous-history
Ctrl-R	reverse-search-history
Ctrl-S	forward-search-history
Ctrl-T	transpose-chars
Ctrl-U	unix-line-discard
Ctrl-W	unix-word-rubout
Ctrl-Y	yank
Ctrl-Z	Suspend (job control works in linux)
Ctrl-H (i.e. Backspace)	backward-delete-char
Ctrl-I (i.e. Tab)	complete
Meta-B	backward-word
Meta-C	capitalize-word
Meta-D	kill-word
Meta-F	forward-word
Meta-L	downcase-word
Meta-U	upcase-word
Meta-Y	yank-pop
Meta-[Backspace]	backward-kill-word
Meta-<	beginning-of-history
Meta->	end-of-history

41.6 Queries

In the mongo (page 908) shell, perform read operations using the db.collection.find() (page 820) and db.collection.findOne() (page 825) methods.

The db.collection.find() (page 820) method returns a cursor object which the mongo (page 908) shell

iterates to print documents on screen. By default, mongo (page 908) prints the first 20. The mongo (page 908) shell will prompt the user to "Type it" to continue iterating the next 20 results.

The following table provides some common read operations in the mongo (page 908) shell:

Read Operations	Description

db.collection.find(<query>) (page 820)	Find the documents matching the <query> criteria in the collection. If the <query> criteria is not specified or is empty (i.e {}), the read operation selects all documents in the collection.
	The following example selects the documents in the users collection with the name field equal to "Joe":
	coll = db.users;
	coll.find({ name: "Joe" });
	For more information on specifying the <query> criteria, see *Query Document* (page 112).

db.collection.find(<query>, <projection>) (page 820)	Find documents matching the <query> criteria and return just specific fields in the <projection>. The following example selects all documents from the collection but returns only the name field and the _id field. The _id is always returned unless explicitly specified to not return. coll = db.users; coll.find({ }, { name: true }); For more information on specifying the <projection>, see *Result Projections* (page 115).

db.collection.find().sort(<sort order>) (page 813)	Return results in the specified <sort order>.
	The following example selects all documents from the collection and returns the results sorted by the name field in ascending order (1). Use -1 for descending order:
	coll = db.users;
	coll.find().sort({ name: 1 });

db.collection.find(<query>).sort(<sort order>) (page 813)	Return the documents matching the <query> criteria in the specified <sort order>.
db.collection.find(...).limit(<n>) (page 807)	Limit result to <n> rows. Highly recommended if you need only a certain number of rows for best performance.
db.collection.find(...).skip(<n>) (page 812)	Skip <n> results.
db.collection.count() (page 816)	Returns total number of documents in the collection.
db.collection.find(<query>).count() (page 804)	Returns the total number of documents that match the query. The count() (page 804) ignores limit() (page 807) and skip() (page 812). For example, if 100 records match but the limit is 10, count() (page 804) will return 100. This will be faster than iterating yourself, but still take time.

db.collection.findOne(<query>) (page 825)	Find and return a single document. Returns null if not found.
	The following example selects a single document in the users collection with the name field matches to "Joe":
	coll = db.users;
	coll.findOne({ name: "Joe" });
	Internally, the findOne() (page 825) method is the find() (page 820) method with a limit(1) (page 807).

See *Read* (page 159) and *Read Operations* (page 111) documentation for more information and examples. See *Query, Update, and Projection Operators Quick Reference* (page 882) to specify other query operators.

41.7 Error Checking Methods

The `mongo` (page 908) shell provides numerous *administrative database methods* (page 891), including error checking methods. These methods are:

Error Checking Methods	Description
`db.getLastError()` (page 849)	Returns error message from the last operation.
`db.getLastErrorObj()` (page 849)	Returns the error document from the last operation.

41.8 Administrative Command Helpers

The following table lists some common methods to support database administration:

JavaScript Database Administration Methods	Description
`db.cloneDatabase(<host>)` (page 815)	Clone the current database from the `host` specified. The `host` database instance must be in noauth mode.
`db.copyDatabase(<from>, <to>, <host>)` (page 844)	Copy the `<from>` database from the `<host>` to the `<to>` database on the current server. The `<host>` database instance must be in `noauth` mode.
`db.fromColl.renameCollection(toColl)` (page 839)	Rename collection from fromColl to toColl.
`db.repairDatabase()` (page 853)	Repair and compact the current database. This operation can be very slow on large databases.
`db.addUser( <user>, <pwd> )` (page 814)	Add user to current database.
`db.getCollectionNames()` (page 849)	Get the list of all collections in the current database.
`db.dropDatabase()` (page 846)	Drops the current database.

See also *administrative database methods* (page 891) for a full list of methods.

41.9 Opening Additional Connections

You can create new connections within the `mongo` (page 908) shell.

The following table displays the methods to create the connections:

JavaScript Connection Create Methods	Description
`db = connect("<host><:port>/<dbname>")`	Open a new database connection.
`conn = new Mongo()` `db = conn.getDB("dbname")`	Open a connection to a new server using `new Mongo()`. Use `getDB()` method of the connection to select a database.

See also *Opening New Connections* (page 477) for more information on the opening new connections from the `mongo` (page 908) shell.

41.10 Miscellaneous

The following table displays some miscellaneous methods:

Method	Description
`Object.bsonsize(<document>)`	Prints the *BSON* size of an <document>

See the MongoDB JavaScript API Documentation for a full list of JavaScript methods .

41.11 Additional Resources

Consider the following reference material that addresses the `mongo` (page 908) shell and its interface:

- *mongo* (page 908)
- *mongo Shell JavaScript Quick Reference* (page 889)
- *Query, Update, and Projection Operators Quick Reference* (page 882)
- *Database Commands Quick Reference* (page 885)
- *Aggregation Framework Reference* (page 211)
- *Meta Query Operator Quick Reference* (page 885)

Additionally, the MongoDB source code repository includes a jstests directory which contains numerous `mongo` (page 908) shell scripts.

The *Getting Started with MongoDB Development* (page 20) provides a general introduction to MongoDB using examples from the `mongo` (page 908) shell. Additionally, the following documents from other sections address topics relevant to the `mongo` (page 908) shell use:

- *FAQ: The mongo Shell* (page 649)
- *mongo* (page 908)
- *mongo Shell JavaScript Quick Reference* (page 889)

Furthermore, consider the following reference material that addresses the `mongo` (page 908) shell and its interface:

- *Query, Update, and Projection Operators Quick Reference* (page 882)
- *Database Commands Quick Reference* (page 885)
- *Aggregation Framework Reference* (page 211)
- *Meta Query Operator Quick Reference* (page 885)

Part XI

Use Cases

The use case documents introduce the patterns, designs, and operations used in application development with MongoDB. Each document provides concrete examples and implementation details to support core MongoDB use cases. These documents highlight application design, and data modeling strategies (*i.e. schema design*) for MongoDB with special attention to pragmatic considerations including indexing, performance, sharding, and scaling. Each document is distinct and can stand alone; however, each section builds on a set of common topics.

The *operational intelligence* case studies describe applications that collect machine generated data from logging systems, application output, and other systems. The *product data management* case studies address aspects of applications required for building product catalogs, and managing inventory in e-commerce systems. The *content management* case studies introduce basic patterns and techniques for building content management systems using MongoDB.

Finally, the *introductory application development tutorials with Python and MongoDB* (page 557), provides a complete and fully developed application that you can build using MongoDB and popular Python web development tool kits.

CHAPTER 42

Operational Intelligence

As an introduction to the use of MongoDB for operational intelligence and real time analytics use, the document "*Storing Log Data* (page 491)" describes several ways and approaches to modeling and storing machine generated data with MongoDB. Then, "*Pre-Aggregated Reports* (page 501)" describes methods and strategies for processing data to generate aggregated reports from raw event-data. Finally "*Hierarchical Aggregation* (page 510)" presents a method for using MongoDB to process and store hierarchical reports (i.e. per-minute, per-hour, and per-day) from raw event data.

42.1 Storing Log Data

42.1.1 Overview

This document outlines the basic patterns and principles for using MongoDB as a persistent storage engine for log data from servers and other machine data.

Problem

Servers generate a large number of events (i.e. logging,) that contain useful information about their operation including errors, warnings, and users behavior. By default, most servers, store these data in plain text log files on their local file systems.

While plain-text logs are accessible and human-readable, they are difficult to use, reference, and analyze without holistic systems for aggregating and storing these data.

Solution

The solution described below assumes that each server generates events also consumes event data and that each server can access the MongoDB instance. Furthermore, this design assumes that the query rate for this logging data is substantially lower than common for logging applications with a high-bandwidth event stream.

Note: This case assumes that you're using an standard uncapped collection for this event data, unless otherwise noted. See the section on *capped collections* (page 501)

Schema Design

The schema for storing log data in MongoDB depends on the format of the event data that you're storing. For a simple example, consider standard request logs in the combined format from the Apache HTTP Server. A line from these logs may resemble the following:

```
127.0.0.1 - frank [10/Oct/2000:13:55:36 -0700] "GET /apache_pb.gif HTTP/1.0" 200 2326 "[http://www.ex
```

The simplest approach to storing the log data would be putting the exact text of the log record into a document:

```
{
  _id: ObjectId('4f442120eb03305789000000'),
 line: '127.0.0.1 - frank [10/Oct/2000:13:55:36 -0700] "GET /apache_pb.gif HTTP/1.0" 200 2326 "[http
}
```

While this solution is does capture all data in a format that MongoDB can use, the data is not particularly useful, or it's not terribly efficient: if you need to find events that the same page, you would need to use a regular expression query, which would require a full scan of the collection. The preferred approach is to extract the relevant information from the log data into individual fields in a MongoDB *document*.

When you extract data from the log into fields, pay attention to the data types you use to render the log data into MongoDB.

As you design this schema, be mindful that the data types you use to encode the data can have a significant impact on the performance and capability of the logging system. Consider the date field: In the above example, `[10/Oct/2000:13:55:36 -0700]` is 28 bytes long. If you store this with the UTC timestamp type, you can convey the same information in only 8 bytes.

Additionally, using proper types for your data also increases query flexibility: if you store date as a timestamp you can make date range queries, whereas it's very difficult to compare two *strings* that represent dates. The same issue holds for numeric fields; storing numbers as strings requires more space and is difficult to query.

Consider the following document that captures all data from the above log entry:

```
{
     _id: ObjectId('4f442120eb03305789000000'),
     host: "127.0.0.1",
     logname: null,
     user: 'frank',
     time: ISODate("2000-10-10T20:55:36Z"),
     path: "/apache_pb.gif",
     request: "GET /apache_pb.gif HTTP/1.0",
     status: 200,
     response_size: 2326,
     referrer: "[http://www.example.com/start.html](http://www.example.com/start.html)",
     user_agent: "Mozilla/4.08 [en] (Win98; I ;Nav)"
}
```

When extracting data from logs and designing a schema, also consider what information you can omit from your log tracking system. In most cases there's no need to track *all* data from an event log, and you can omit other fields. To continue the above example, here the most crucial information may be the host, time, path, user agent, and referrer, as in the following example document:

```
{
     _id: ObjectId('4f442120eb03305789000000'),
     host: "127.0.0.1",
     time:  ISODate("2000-10-10T20:55:36Z"),
     path: "/apache_pb.gif",
     referer: "[http://www.example.com/start.html](http://www.example.com/start.html)",
```

```
    user_agent: "Mozilla/4.08 [en] (Win98; I ;Nav)"
}
```

You may also consider omitting explicit time fields, because the `ObjectId` embeds creation time:

```
{
    _id: ObjectId('4f442120eb03305789000000'),
    host: "127.0.0.1",
    path: "/apache_pb.gif",
    referer: "[http://www.example.com/start.html](http://www.example.com/start.html)",
    user_agent: "Mozilla/4.08 [en] (Win98; I ;Nav)"
}
```

System Architecture

The primary performance concern for event logging systems are:

1. how many inserts per second can it support, which limits the event throughput, and
2. how will the system manage the growth of event data, particularly concerning a growth in insert activity.

   In most cases the best way to increase the capacity of the system is to use an architecture with some sort of *partitioning* or *sharding* that distributes writes among a cluster of systems.

42.1.2 Operations

Insertion speed is the primary performance concern for an event logging system. At the same time, the system must be able to support flexible queries so that you can return data from the system efficiently. This section describes procedures for both document insertion and basic analytics queries.

The examples that follow use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose.

Inserting a Log Record

Write Concern

MongoDB has a configurable *write concern*. This capability allows you to balance the importance of guaranteeing that all writes are fully recorded in the database with the speed of the insert.

For example, if you issue writes to MongoDB and do not require that the database issue any response, the write operations will return *very* fast (i.e. asynchronously,) but you cannot be certain that all writes succeeded. Conversely, if you require that MongoDB acknowledge every write operation, the database will not return as quickly but you can be certain that every item will be present in the database.

The proper write concern is often an application specific decision, and depends on the reporting requirements and uses of your analytics application.

Insert Performance

The following example contains the setup for a Python console session using PyMongo, with an event from the Apache Log:

```
>>> import bson
>>> import pymongo
>>> from datetime import datetime
>>> conn = pymongo.Connection()
>>> db = conn.event_db
>>> event = {
...     _id: bson.ObjectId(),
...     host: "127.0.0.1",
...     time:  datetime(2000,10,10,20,55,36),
...     path: "/apache_pb.gif",
...     referer: "[http://www.example.com/start.html](http://www.example.com/start.html)",
...     user_agent: "Mozilla/4.08 [en] (Win98; I ;Nav)"
...}
```

The following command will insert the `event` object into the `events` collection.

```
>>> db.events.insert(event, w=0)
```

By setting `w=0`, you do not require that MongoDB acknowledges receipt of the insert. Although very fast, this is risky because the application cannot detect network and server failures. See *Write Concern* (page 124) for more information.

If you want to ensure that MongoDB acknowledges inserts, you can pass `w=1` argument as follows:

```
>>> db.events.insert(event, w=1)
```

MongoDB also supports a more stringent level of write concern, if you have a lower tolerance for data loss:

You can ensure that MongoDB not only *acknowledge* receipt of the message but also commit the write operation to the on-disk journal before returning successfully to the application, use can use the following `insert()` operation:

```
>>> db.events.insert(event, j=True)
```

Note: `j=True` implies `w=1`.

Finally, if you have *extremely low* tolerance for event data loss, you can require that MongoDB replicate the data to multiple *secondary replica set* members before returning:

```
>>> db.events.insert(event, w=majority)
```

This will force your application to acknowledge that the data has replicated to a majority of configured members of the *replica set*. You can combine options as well:

```
>>> db.events.insert(event, j=True, w=majority)
```

In this case, your application will wait for a successful journal commit on the *primary and* a replication acknowledgment from a majority of configured secondaries. This is the safest option presented in this section, but it is the slowest. There is always a trade-off between safety and speed.

Note: If possible, consider using bulk inserts to insert event data.

All write concern options apply to bulk inserts, but you can pass multiple events to the `insert()` method at once. Batch inserts allow MongoDB to distribute the performance penalty incurred by more stringent write concern across a group of inserts.

See Also:

"*Write Concern for Replica Sets* (page 303)" and `getLastError` (page 766).

Finding All Events for a Particular Page

The value in maintaining a collection of event data derives from being able to query that data to answer specific questions. You may have a number of simple queries that you may use to analyze these data.

As an example, you may want to return all of the events associated with specific value of a field. Extending the Apache access log example from above, a common case would be to query for all events with a specific value in the `path` field: This section contains a pattern for returning data and optimizing this operation.

Query

Use a query that resembles the following to return all documents with the `http://docs.mongodb.org/v2.2/apache_pb.gif` value in the `path` field:

```
>>> q_events = db.events.find({'path': '/apache_pb.gif'})
```

Note: If you choose to *shard* the collection that stores this data, the *shard key* you choose can impact the performance of this query. See the *sharding* (page 499) section of the sharding document.

Index Support

Adding an index on the `path` field would significantly enhance the performance of this operation.

```
>>> db.events.ensure_index('path')
```

Because the values of the `path` likely have a random distribution, in order to operate efficiently, the entire index should be resident in RAM. In this case, the number of distinct paths is typically small in relation to the number of documents, which will limit the space that the index requires.

If your system has a limited amount of RAM, or your data set has a wider distribution in values, you may need to re investigate your indexing support. In most cases, however, this index is entirely sufficient.

See Also:

The `db.collection.ensureIndex()` (page 819) JavaScript method and the `db.events.ensure_index()` method in PyMongo.

Finding All the Events for a Particular Date

The next example describes the process for returning all the events for a particular date.

Query

To retrieve this data, use the following query:

```
>>> q_events = db.events.find('time':
...     { '$gte':datetime(2000,10,10),'$lt':datetime(2000,10,11)})
```

Index Support

In this case, an index on the `time` field would optimize performance:

```
>>> db.events.ensure_index('time')
```

Because your application is inserting events in order, the parts of the index that capture recent events will always be in active RAM. As a result, if you query primarily on recent data, MongoDB will be able to maintain a large index, quickly fulfill queries, and avoid using much system memory.

See Also:

The `db.events.ensureIndex()` (page 819) JavaScript method and the `db.events.ensure_index()` method in PyMongo.

Finding All Events for a Particular Host/Date

The following example describes a more complex query for returning all events in the collection for a particular host on a particular date. This kinds analysis may be useful for investigating suspicious behavior by a specific user.

Query

Use a query that resembles the following:

```
>>> q_events = db.events.find({
...     'host': '127.0.0.1',
...     'time': {'$gte':datetime(2000,10,10),'$lt':datetime(2000,10,11)}
... })
```

This query selects *documents* from the `events` collection where the `host` field is `127.0.0.1` (i.e. local host), and the value of the `time` field represents a date that is on or after (i.e. `$gte` (page 697)) `2000-10-10` but before (i.e. `$lt` (page 700)) `2000-10-11`.

Index Support

The indexes you use may have significant implications for the performance of these kinds of queries. For instance, you *can* create a compound index on the `time` and `host` field, using the following command:

```
>>> db.events.ensure_index([('time', 1), ('host', 1)])
```

To analyze the performance for the above query using this index, issue the `q_events.explain()` method in a Python console. This will return something that resembles:

```
{ ...
  u'cursor': u'BtreeCursor time_1_host_1',
  u'indexBounds': {u'host': [[u'127.0.0.1', u'127.0.0.1']],
  u'time': [
      [ datetime.datetime(2000, 10, 10, 0, 0),
        datetime.datetime(2000, 10, 11, 0, 0)]]
  },
  ...
  u'millis': 4,
  u'n': 11,
  u'nscanned': 1296,
  u'nscannedObjects': 11,
  ... }
```

This query had to scan 1296 items from the index to return 11 objects in 4 milliseconds. Conversely, you can test a different compound index with the `host` field first, followed by the `time` field. Create this index using the following operation:

```
>>> db.events.ensure_index([('host', 1), ('time', 1)])
```

Use the `q_events.explain()` operation to test the performance:

```
{ ...
  u'cursor': u'BtreeCursor host_1_time_1',
  u'indexBounds': {u'host': [[u'127.0.0.1', u'127.0.0.1']],
  u'time': [[datetime.datetime(2000, 10, 10, 0, 0),
      datetime.datetime(2000, 10, 11, 0, 0)]]},
  ...
  u'millis': 0,
  u'n': 11,
  ...
  u'nscanned': 11,
  u'nscannedObjects': 11,
  ...
}
```

Here, the query had to scan 11 items from the index before returning 11 objects in less than a millisecond. By placing the more selective element of your query *first* in a compound index you may be able to build more useful queries.

Note: Although the index order has an impact query performance, remember that index scans are *much* faster than collection scans, and depending on your other queries, it may make more sense to use the `{ time: 1, host: 1 }` index depending on usage profile.

See Also:

The `db.events.ensureIndex()` (page 819) JavaScript method and the `db.events.ensure_index()` method in PyMongo.

Counting Requests by Day and Page

The following example describes the process for using the collection of Apache access events to determine the number of request per resource (i.e. page) per day in the last month.

Aggregation

New in version 2.1. The *aggregation framework* provides the capacity for queries that select, process, and aggregate results from large numbers of documents. The `aggregate()` (page 815) offers greater flexibility, capacity with less complexity than the existing `mapReduce` (page 775) and `group` (page 769) aggregation commands.

Consider the following aggregation *pipeline*: [1]

```
>>> result = db.command('aggregate', 'events', pipeline=[
...         {  '$match': {
...               'time': {
...                   '$gte': datetime(2000,10,1),
...                   '$lt':  datetime(2000,11,1) } } },
...         {  '$project': {
```

[1] To translate statements from the *aggregation framework* (page 195) to SQL, you can consider the `$match` (page 731) equivalent to `WHERE`, `$project` (page 733) to `SELECT`, and `$group` (page 728) to `GROUP BY`.

```
...                 'path': 1,
...                 'date': {
...                     'y': { '$year': '$time' },
...                     'm': { '$month': '$time' },
...                     'd': { '$dayOfMonth': '$time' } } } },
...         { '$group': {
...                 '_id': {
...                     'p':'$path',
...                     'y': '$date.y',
...                     'm': '$date.m',
...                     'd': '$date.d' },
...                 'hits': { '$sum': 1 } } },
...         ])
```

This command aggregates documents from the `events` collection with a pipeline that:

1. Uses the `$match` (page 731) to limit the documents that the aggregation framework must process. `$match` (page 731) is similar to a `find()` (page 820) query.

   This operation selects all documents where the value of the `time` field represents a date that is on or after (i.e. `$gte` (page 697)) `2000-10-10` but before (i.e. `$lt` (page 700)) `2000-10-11`.

2. Uses the `$project` (page 733) to limit the data that continues through the pipeline. This operator:

   - Selects the `path` field.
   - Creates a `y` field to hold the year, computed from the `time` field in the original documents.
   - Creates a `m` field to hold the month, computed from the `time` field in the original documents
   - Creates a `d` field to hold the day, computed from the `time` field in the original documents.

3. Uses the `$group` (page 728) to create new computed documents. This step will create a single new document for each unique path/date combination. The documents take the following form:

   - the `_id` field holds a sub-document with the contents `path` field from the original documents in the `p` field, with the `date` fields from the `$project` (page 733) as the remaining fields.
   - the `hits` field use the `$sum` (page 737) statement to increment a counter for every document in the group. In the aggregation output, this field holds the total number of documents at the beginning of the aggregation pipeline with this unique date and path.

Note: In sharded environments, the performance of aggregation operations depends on the *shard key*. Ideally, all the items in a particular `$group` (page 728) operation will reside on the same server.

While this distribution of documents would occur if you chose the `time` field as the shard key, a field like `path` also has this property and is a typical choice for sharding. Also see the "*sharding considerations* (page 499)." of this document for additional recommendations for using sharding.

See Also:

"*Aggregation Framework* (page 195)"

Index Support

To optimize the aggregation operation, ensure that the initial `$match` (page 731) query has an index. Use the following command to create an index on the `time` field in the `events` collection:

```
>>> db.events.ensure_index('time')
```

Note: If you have already created a compound index on the `time` and `host` (i.e. `{ time: 1, host, 1 }`,) MongoDB will use this index for range queries on just the `time` field. Do not create an additional index, in these situations.

42.1.3 Sharding

Eventually your system's events will exceed the capacity of a single event logging database instance. In these situations you will want to use a *sharded cluster*, which takes advantage of MongoDB's *sharding* functionality. This section introduces the unique sharding concerns for this event logging case.

See Also:

Sharding (page 363) and *FAQ: Sharding with MongoDB* (page 659)

Limitations

In a sharded environment the limitations on the maximum insertion rate are:

- the number of shards in the cluster.
- the *shard key* you chose.

Because MongoDB distributed data in using "ranges" (i.e. *chunks*) of *keys*, the choice of shard key can control how MongoDB distributes data and the resulting systems' capacity for writes and queries.

Ideally, your shard key should allow insertions balance evenly among the shards [2] and for most queries to only *need* to access a single shard. [3] Continue reading for an analysis of a collection of shard key choices.

Shard by Time

While using the timestamp, or the `ObjectId` in the `_id` field, [4] would distribute your data evenly among shards, these keys lead to two problems:

1. All inserts always flow to the same shard, which means that your *sharded cluster* will have the same write throughput as a standalone instance.
2. Most reads will tend to cluster on the same shard, as analytics queries.

Shard by a Semi-Random Key

To distribute data more evenly among the shards, you may consider using a more "random" piece of data, such as a hash of the `_id` field (i.e. the `ObjectId` as a *shard key*.

While this introduces some additional complexity into your application, to generate the key, it will distribute writes among the shards. In these deployments having 5 shards will provide 5 times the write capacity as a single instance.

Using this shard key, or any hashed value as a key presents the following downsides:

- the shard key, and the index on the key will consume additional space in the database.

[2] For this reason, avoid shard keys based on the timestamp or the insertion time (i.e. the `ObjectId`) because all writes will end up on a single node.

[3] For this reason, avoid randomized shard keys (e.g. hash based shard keys) because any query will have to access all shards in the cluster.

[4] The `ObjectId` derives from the creation time, and is effectively a timestamp in this case.

- queries, unless they include the shard key itself, [5] must run in parallel on all shards, which may lead to degraded performance.

This might be an acceptable trade-off in some situations. The workload of event logging systems tends to be heavily skewed toward writing, read performance may not be as critical as more robust write performance.

Shard by an Evenly-Distributed Key in the Data Set

If a field in your documents has values that are evenly distributed among the documents, you may consider using this key as a *shard key*.

Continuing the example from above, you may consider using the `path` field. Which may have a couple of advantages:

1. writes will tend to balance evenly among shards.
2. reads will tend to be selective and local to a single shard if the query selects on the `path` field.

There are a few potential problems with these kinds of shard keys:

1. If a large number of documents will have the same shard key, you run the risk of having a portion of your data collection MongoDB cannot distribute throughout the cluster.
2. If there are a small number of possible values, there may be a limit to how much MongoDB will be able to distribute the data among the shard.

Note: Test using your existing data to ensure that the distribution is truly even, and that there is a sufficient quantity of distinct values for the shard key.

Shard by Combine a Natural and Synthetic Key

MongoDB supports compound *shard keys* that combine the best aspects of *sharding by a evenly distributed key in the set* (page 500) and *sharding by a random key* (page 499). In these situations, the shard key would resemble `{ path: 1 , ssk: 1 }` where, `path` is an often used "natural key, or value from your data and `ssk` is a hash of the `_id` field. [6]

Using this type of shard key, data is largely distributed by the natural key, or `path`, which makes most queries that access the `path` field local to a single shard or group of shards. At the same time, if there is not sufficient distribution for specific values of `path`, the `ssk` makes it possible for MongoDB to create *chunks* and data across the cluster.

In most situations, these kinds of keys provide the ideal balance between distributing writes across the cluster and ensuring that most queries will only need to access a select number of shards.

Test with Your Own Data

Selecting shard keys is difficult because: there are no definitive "best-practices," the decision has a large impact on performance, and it is difficult or impossible to change the shard key after making the selection.

The *sharding options* (page 499) provides a good starting point for thinking about *shard key* selection. Nevertheless, the best way to select a shard key is to analyze the actual insertions and queries from your own application.

[5] Typically, it is difficult to use these kinds of shard keys in queries.
[6] You must still calculate the value of this synthetic key in your application when you insert documents into your collection.

42.1.4 Managing Event Data Growth

Without some strategy for managing the size of your database, most event logging systems can grow infinitely. This is particularly important in the context of MongoDB may not relinquish data to the file system in the way you might expect. Consider the following strategies for managing data growth:

Capped Collections

Depending on your data retention requirements as well as your reporting and analytics needs, you may consider using a *capped collection* to store your events. Capped collections have a fixed size, and drop old data when inserting new data after reaching cap.

Note: In the current version, it is not possible to shard capped collections.

Multiple Collections, Single Database

Strategy: Periodically rename your event collection so that your data collection rotates in much the same way that you might rotate log files. When needed, you can drop the oldest collection from the database.

This approach has several advantages over the single collection approach:

1. Collection renames are fast and atomic.
2. MongoDB does not bring any document into memory to drop a collection.
3. MongoDB can effectively reuse space freed by removing entire collections without leading to data fragmentation.

Nevertheless, this operation may increase some complexity for queries, if any of your analyses depend on events that may reside in the current and previous collection. For most real time data collection systems, this approach is the most ideal.

Multiple Databases

Strategy: Rotate databases rather than collections, as in the "*Multiple Collections, Single Database* (page 501) example.

While this *significantly* increases application complexity for insertions and queries, when you drop old databases, MongoDB will return disk space to the file system. This approach makes the most sense in scenarios where your event insertion rates and/or your data retention rates were extremely variable.

For example, if you are performing a large backfill of event data and want to make sure that the entire set of event data for 90 days is available during the backfill, during normal operations you only need 30 days of event data, you might consider using multiple databases.

42.2 Pre-Aggregated Reports

42.2.1 Overview

This document outlines the basic patterns and principles for using MongoDB as an engine for collecting and processing events in real time for use in generating up to the minute or second reports.

Problem

Servers and other systems can generate a large number of documents, and it can be difficult to access and analyze such large collections of data originating from multiple servers.

This document makes the following assumptions about real-time analytics:

- There is no need to retain transactional event data in MongoDB, and how your application handles transactions is outside of the scope of this document.
- You require up-to-the minute data, or up-to-the-second if possible.
- The queries for ranges of data (by time) must be as fast as possible.

See Also:

"*Storing Log Data* (page 491)."

Solution

The solution described below assumes a simple scenario using data from web server access logs. With this data, you will want to return the number of hits to a collection of web sites at various levels of granularity based on time (i.e. by minute, hour, day, week, and month) as well as by the path of a resource.

To achieve the required performance to support these tasks, *upserts* and `increment` (page 699) operations will allow you to calculate statistics, produce simple range-based queries, and generate filters to support time-series charts of aggregated data.

42.2.2 Schema

Schemas for real-time analytics systems must support simple and fast query and update operations. In particular, attempt to avoid the following situations which can degrade performance:

- *documents* growing significantly after creation.

  Document growth forces MongoDB to move the document on disk, which can be time and resource consuming relative to other operations;

- queries requiring MongoDB to scan documents in the collection without using indexes; and
- deeply nested documents that make accessing particular fields slow.

Intuitively, you may consider keeping "hit counts" in individual documents with one document for every unit of time (i.e. minute, hour, day, etc.) However, queries must return multiple documents for all non-trivial time-rage queries, which can slow overall query performance.

Preferably, to maximize query performance, use more complex documents, and keep several aggregate values in each document. The remainder of this section outlines several schema designs that you may consider for this real-time analytics system. While there is no single pattern for every problem, each pattern is more well suited to specific classes of problems.

One Document Per Page Per Day

Consider the following example schema for a solution that stores all statistics for a single day and page in a single *document*:

```
{
    _id: "20101010/site-1/apache_pb.gif",
    metadata: {
        date: ISODate("2000-10-10T00:00:00Z"),
        site: "site-1",
        page: "/apache_pb.gif" },
    daily: 5468426,
    hourly: {
        "0": 227850,
        "1": 210231,
        ...
        "23": 20457 },
    minute: {
        "0": 3612,
        "1": 3241,
        ...
        "1439": 2819 }
}
```

This approach has a couple of advantages:

- For every request on the website, you only need to update one document.
- Reports for time periods within the day, for a single page require fetching a single document.

There are, however, significant issues with this approach. The most significant issue is that, as you *upsert* data into the `hourly` and `monthly` fields, the document grows. Although MongoDB will pad the space allocated to documents, it must still will need to reallocate these documents multiple times throughout the day, which impacts performance.

Pre-allocate Documents

Simple Pre-Allocation

To mitigate the impact of repeated document migrations throughout the day, you can tweak the "*one document per page per day* (page 502)" approach by adding a process that "pre-allocates" documents with fields that hold `0` values throughout the previous day. Thus, at midnight, new documents will exist.

Note: To avoid situations where your application must pre-allocate large numbers of documents at midnight, it's best to create documents throughout the previous day by *upserting* randomly when you update a value in the current day's data.

This requires some tuning, to balance two requirements:

1. your application should have pre-allocated all or nearly all of documents by the end of the day.
2. your application should infrequently pre-allocate a document that already exists to save time and resources on extraneous upserts.

As a starting point, consider the average number of hits a day (`h`), and then upsert a blank document upon update with a probability of `1/h`.

Pre-allocating increases performance by initializing all documents with `0` values in all fields. After create, documents will never grow. This means that:

1. there will be no need to migrate documents within the data store, which is a problem in the "*one document per page per day* (page 502)" approach.

2. MongoDB will not add padding to the records, which leads to a more compact data representation and better memory use of your memory.

Add Intra-Document Hierarchy

Note: MongoDB stores *BSON documents* as a sequence of fields and values, *not* as a hash table. As a result, writing to the field `stats.mn.0` is considerably faster than writing to `stats.mn.1439`.

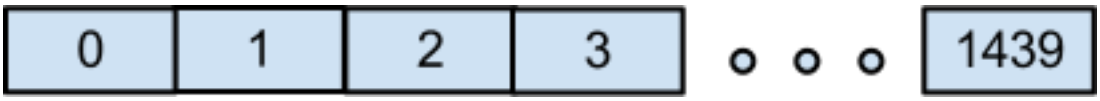


Figure 42.1: In order to update the value in minute #1349, MongoDB must skip over all 1349 entries before it.

To optimize update and insert operations you can introduce intra-document hierarchy. In particular, you can split the `minute` field up into 24 hourly fields:

```
{
    _id: "20101010/site-1/apache_pb.gif",
    metadata: {
        date: ISODate("2000-10-10T00:00:00Z"),
        site: "site-1",
        page: "/apache_pb.gif" },
    daily: 5468426,
    hourly: {
        "0": 227850,
        "1": 210231,
        ...
        "23": 20457 },
    minute: {
        "0": {
            "0": 3612,
            "1": 3241,
            ...
            "59": 2130 },
        "1": {
        "60": ... ,
        },
        ...
        "23": {
            ...
            "1439": 2819 }
    }
}
```

This allows MongoDB to "skip forward" throughout the day when updating the minute data, which makes the update performance more uniform and faster later in the day.

Separate Documents by Granularity Level

Pre-allocating documents (page 503) is a reasonable design for storing intra-day data, but the model breaks down when displaying data over longer multi-day periods like months or quarters. In these cases, consider storing daily statistics in a single document as above, and then aggregate monthly data into a separate document.

Figure 42.2: To update the value in minute #1349, MongoDB first skips the first 23 hours and then skips 59 minutes for only 82 skips as opposed to 1439 skips in the previous schema.

This introduce a second set of *upsert* operations to the data collection and aggregation portion of your application but the gains reduction in disk seeks on the queries, should be worth the costs. Consider the following example schema:

1. Daily Statistics

```
{
    _id: "20101010/site-1/apache_pb.gif",
    metadata: {
        date: ISODate("2000-10-10T00:00:00Z"),
        site: "site-1",
        page: "/apache_pb.gif" },
    hourly: {
        "0": 227850,
        "1": 210231,
        ...
        "23": 20457 },
    minute: {
        "0": {
            "0": 3612,
            "1": 3241,
            ...
            "59": 2130 },
        "1": {
            "0": ...,
        },
        ...
        "23": {
            "59": 2819 }
    }
}
```

2. Monthly Statistics

```
{
    _id: "201010/site-1/apache_pb.gif",
    metadata: {
        date: ISODate("2000-10-00T00:00:00Z"),
        site: "site-1",
        page: "/apache_pb.gif" },
    daily: {
        "1": 5445326,
        "2": 5214121,
        ... }
}
```

42.2.3 Operations

This section outlines a number of common operations for building and interacting with real-time-analytics reporting system. The major challenge is in balancing performance and write (i.e. *upsert*) performance. All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose.

Log an Event

Logging an event such as a page request (i.e. "hit") is the main "write" activity for your system. To maximize performance, you'll be doing in-place updates with the *upsert* operation. Consider the following example:

```
from datetime import datetime, time

def log_hit(db, dt_utc, site, page):

    # Update daily stats doc
    id_daily = dt_utc.strftime('%Y%m%d/') + site + page
    hour = dt_utc.hour
    minute = dt_utc.minute

    # Get a datetime that only includes date info
    d = datetime.combine(dt_utc.date(), time.min)
    query = {
        '_id': id_daily,
        'metadata': { 'date': d, 'site': site, 'page': page } }
    update = { '$inc': {
            'hourly.%d' % (hour,): 1,
            'minute.%d.%d' % (hour,minute): 1 } }
    db.stats.daily.update(query, update, upsert=True)

    # Update monthly stats document
    id_monthly = dt_utc.strftime('%Y%m/') + site + page
    day_of_month = dt_utc.day
    query = {
        '_id': id_monthly,
        'metadata': {
            'date': d.replace(day=1),
            'site': site,
            'page': page } }
    update = { '$inc': {
            'daily.%d' % day_of_month: 1} }
    db.stats.monthly.update(query, update, upsert=True)
```

The upsert operation (i.e. `upsert=True`) performs an update if the document exists, and an insert if the document does not exist.

Note: This application requires upserts, because the *pre-allocation* (page 507) method only pre-allocates new documents with a high probability, not with complete certainty.

Without preallocation, you end up with a dynamically growing document, slowing upserts as MongoDB moves documents to accommodate growth.

Pre-allocate

To prevent document growth, you can preallocate new documents before the system needs them. As you create new documents, set all values to `0` for so that documents will not grow to accommodate updates. Consider the following `preallocate()` function:

```
def preallocate(db, dt_utc, site, page):

    # Get id values
    id_daily = dt_utc.strftime('%Y%m%d/') + site + page
    id_monthly = dt_utc.strftime('%Y%m/') + site + page

    # Get daily metadata
    daily_metadata = {
        'date': datetime.combine(dt_utc.date(), time.min),
        'site': site,
        'page': page }
    # Get monthly metadata
    monthly_metadata = {
        'date': daily_metadata['date'].replace(day=1),
        'site': site,
        'page': page }

    # Initial zeros for statistics
    hourly = dict((str(i), 0) for i in range(24))
    minute = dict(
        (str(i), dict((str(j), 0) for j in range(60)))
        for i in range(24))
    daily = dict((str(i), 0) for i in range(1, 32))

    # Perform upserts, setting metadata
    db.stats.daily.update(
        {
            '_id': id_daily,
            'hourly': hourly,
            'minute': minute},
        { '$set': { 'metadata': daily_metadata }},
        upsert=True)
    db.stats.monthly.update(
        {
            '_id': id_monthly,
            'daily': daily },
        { '$set': { 'm': monthly_metadata }},
        upsert=True)
```

The function pre-allocated both the monthly *and* daily documents at the same time. The performance benefits from separating these operations are negligible, so it's reasonable to keep both operations in the same function.

Ideally, your application should pre-allocate documents *before* needing to write data to maintain consistent update performance. Additionally, its important to avoid causing a spike in activity and latency by creating documents all at once.

In the following example, document updates (i.e. "`log_hit()`") will also pre-allocate a document probabilistically. However, by "tuning probability," you can limit redundant `preallocate()` calls.

```
from random import random
from datetime import datetime, timedelta, time

# Example probability based on 500k hits per day per page
```

```
prob_preallocate = 1.0 / 500000

def log_hit(db, dt_utc, site, page):
    if random.random() < prob_preallocate:
        preallocate(db, dt_utc + timedelta(days=1), site, page)
    # Update daily stats doc
    ...
```

Using this method, there will be a high probability that each document will already exist before your application needs to issue update operations. You'll also be able to prevent a regular spike in activity for pre-allocation, and be able to eliminate document growth.

Retrieving Data for a Real-Time Chart

This example describes fetching the data from the above MongoDB system, for use in generating a chart that displays the number of hits to a particular resource over the last hour.

Querying

Use the following query in a `find_one` operation at the Python/PyMongo console to retrieve the number of hits to a specific resource (i.e. `http://docs.mongodb.org/v2.2/index.html`) with minute-level granularity:

```
>>> db.stats.daily.find_one(
...     {'metadata': {'date':dt, 'site':'site-1', 'page':'/index.html'}},
...     { 'minute': 1 })
```

Use the following query to retrieve the number of hits to a resource over the last day, with hour-level granularity:

```
>>> db.stats.daily.find_one(
...     {'metadata': {'date':dt, 'site':'site-1', 'page':'/foo.gif'}},
...     { 'hourly': 1 })
```

If you want a few days of hourly data, you can use a query in the following form:

```
>>> db.stats.daily.find(
...     {
...         'metadata.date': { '$gte': dt1, '$lte': dt2 },
...         'metadata.site': 'site-1',
...         'metadata.page': '/index.html'},
...     { 'metadata.date': 1, 'hourly': 1 } },
...     sort=[('metadata.date', 1)])
```

Indexing

To support these query operation, create a compound index on the following daily statistics fields: `metadata.site`, `metadata.page`, and `metadata.date` (in that order.) Use the following operation at the Python/PyMongo console.

```
>>> db.stats.daily.ensure_index([
...     ('metadata.site', 1),
...     ('metadata.page', 1),
...     ('metadata.date', 1)])
```

This index makes it possible to efficiently run the query for multiple days of hourly data. At the same time, any compound index on page and date, will allow you to query efficiently for a single day's statistics.

Get Data for a Historical Chart

Querying

To retrieve daily data for a single month, use the following query:

```
>>> db.stats.monthly.find_one(
...     {'metadata':
...         {'date':dt,
...         'site': 'site-1',
...         'page':'/index.html'}},
...     { 'daily': 1 })
```

To retrieve several months of daily data, use a variation on the above query:

```
>>> db.stats.monthly.find(
...     {
...         'metadata.date': { '$gte': dt1, '$lte': dt2 },
...         'metadata.site': 'site-1',
...         'metadata.page': '/index.html'},
...     { 'metadata.date': 1, 'daily': 1 } },
...     sort=[('metadata.date', 1)])
```

Indexing

Create the following index to support these queries for monthly data on the `metadata.site`, `metadata.page`, and `metadata.date` fields:

```
>>> db.stats.monthly.ensure_index([
...     ('metadata.site', 1),
...     ('metadata.page', 1),
...     ('metadata.date', 1)])
```

This field order will efficiently support range queries for a single page over several months.

42.2.4 Sharding

The only potential limits on the performance of this system are the number of *shards* in your *system*, and the *shard key* that you use.

> An ideal shard key will distribute *upserts* between the shards while routing all queries to a single shard, or a small number of shards.

While your choice of shard key may depend on the precise workload of your deployment, consider using `{ metadata.site: 1, metadata.page: 1 }` as a *shard key*. The combination of site and page (or event) will lead to a well balanced cluster for most deployments.

Enable sharding for the daily statistics collection with the following `shardCollection` (page 794) command in the Python/PyMongo console:

```
>>> db.command('shardCollection', 'stats.daily', {
...     key : { 'metadata.site': 1, 'metadata.page' : 1 } })
```

Upon success, you will see the following response:

```
{ "collectionsharded" : "stats.daily", "ok" : 1 }
```

Enable sharding for the monthly statistics collection with the following `shardCollection` (page 794) command in the Python/PyMongo console:

```
>>> db.command('shardCollection', 'stats.monthly', {
...     key : { 'metadata.site': 1, 'metadata.page' : 1 } })
```

Upon success, you will see the following response:

```
{ "collectionsharded" : "stats.monthly", "ok" : 1 }
```

One downside of the `{ metadata.site: 1, metadata.page: 1 }` *shard key* is: if one page dominates all your traffic, all updates to that page will go to a single shard. This is basically unavoidable, since all update for a single page are going to a single *document*.

You may wish to include the date in addition to the site, and page fields so that MongoDB can split histories so that you can serve different historical ranges with different shards. Use the following `shardCollection` (page 794) command to shard the daily statistics collection in the Python/PyMongo console:

```
>>> db.command('shardCollection', 'stats.daily', {
...     'key':{'metadata.site':1,'metadata.page':1,'metadata.date':1}})
{ "collectionsharded" : "stats.daily", "ok" : 1 }
```

Enable sharding for the monthly statistics collection with the following `shardCollection` (page 794) command in the Python/PyMongo console:

```
>>> db.command('shardCollection', 'stats.monthly', {
...     'key':{'metadata.site':1,'metadata.page':1,'metadata.date':1}})
{ "collectionsharded" : "stats.monthly", "ok" : 1 }
```

Note: Determine your actual requirements and load before deciding to shard. In many situations a single MongoDB instance may be able to keep track of all events and pages.

42.3 Hierarchical Aggregation

42.3.1 Overview

Background

If you collect a large amount of data, but do not *pre-aggregate* (page 501), and you want to have access to aggregated information and reports, then you need a method to aggregate these data into a usable form. This document provides an overview of these aggregation patterns and processes.

For clarity, this case study assumes that the incoming event data resides in a collection named `events`. For details on how you might get the event data into the events collection, please see "*Storing Log Data* (page 491)" document. This document continues using this example.

Solution

The first step in the aggregation process is to aggregate event data into the finest required granularity. Then use this aggregation to generate the next least specific level granularity and this repeat process until you have generated all required views.

The solution uses several collections: the raw data (i.e. `events`) collection as well as collections for aggregated hourly, daily, weekly, monthly, and yearly statistics. All aggregations use the `mapReduce` (page 775) *command*, in a hierarchical process. The following figure illustrates the input and output of each job:

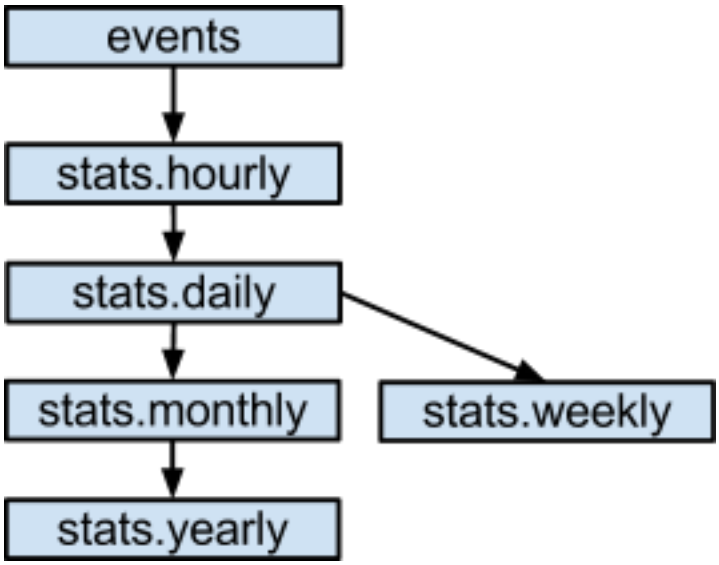


Figure 42.3: Hierarchy of data aggregation.

Note: Aggregating raw events into an hourly collection is qualitatively different from the operation that aggregates hourly statistics into the daily collection.

See Also:

map-reduce and the *Map-Reduce* (page 223) page for more information on the Map-reduce data aggregation paradigm.

42.3.2 Schema

When designing the schema for event storage, it's important to track the events included in the aggregation and events that are not yet included.

Relational Approach

A simple tactic from relational database, uses an auto-incremented integer as the primary key. However, this introduces a significant performance penalty for event logging process because the aggregation process must fetch new keys one at a time.

If you can batch your inserts into the `events` collection, you can use an auto-increment primary key by using the `find_and_modify` command to generate the `_id` values, as in the following example:

```
>>> obj = db.my_sequence.find_and_modify(
...     query={'_id':0},
...     update={'$inc': {'inc': 50}}
...     upsert=True,
...     new=True)
>>> batch_of_ids = range(obj['inc']-50, obj['inc'])
```

However, in most cases you can simply include a timestamp with each event that you can use to distinguish processed events from unprocessed events.

This example assumes that you are calculating average session length for logged-in users on a website. The events will have the following form:

```
{
    "userid": "rick",
    "ts": ISODate('2010-10-10T14:17:22Z'),
    "length":95
}
```

The operations described in the next session will calculate total and average session times for each user at the hour, day, week, month and year. For each aggregation you will want to store the number of sessions so that MongoDB can incrementally recompute the average session times. The aggregate document will resemble the following:

```
{
   _id: { u: "rick", d: ISODate("2010-10-10T14:00:00Z") },
   value: {
       ts: ISODate('2010-10-10T15:01:00Z'),
       total: 254,
       count: 10,
       mean: 25.4 }
}
```

Note: The timestamp value in the `_id` sub-document, which will allow you to incrementally update documents at various levels of the hierarchy.

42.3.3 Operations

This section assumes that all events exist in the `events` collection and have a timestamp. The operations, thus are to aggregate from the `events` collection into the smallest aggregate–hourly totals– and then aggregate from the hourly totals into coarser granularity levels. In all cases, these operations will store aggregation time as a `last_run` variable.

Creating Hourly Views from Event Collections

Aggregation

Note: Although this solution uses Python and PyMongo to connect with MongoDB, you must pass JavaScript functions (i.e. `mapf`, `reducef`, and `finalizef`) to the `mapReduce` (page 775) command.

Begin by creating a map function, as below:

```
mapf_hour = bson.Code('''function() {
    var key = {
        u: this.userid,
        d: new Date(
            this.ts.getFullYear(),
            this.ts.getMonth(),
            this.ts.getDate(),
            this.ts.getHours(),
            0, 0, 0);
    emit(
```

```
        key,
        {
            total: this.length,
            count: 1,
            mean: 0,
            ts: new Date(); });
}''')
```

In this case, it emits key-value pairs that contain the data you want to aggregate as you'd expect. The function also emits a `ts` value that makes it possible to cascade aggregations to coarser grained aggregations (i.e. hour to day, etc.)

Consider the following reduce function:

```
reducef = bson.Code('''function(key, values) {
    var r = { total: 0, count: 0, mean: 0, ts: null };
    values.forEach(function(v) {
        r.total += v.total;
        r.count += v.count;
    });
    return r;
}''')
```

The reduce function returns a document in the same format as the output of the map function. This pattern for map and reduce functions makes map-reduce processes easier to test and debug.

While the reduce function ignores the `mean` and `ts` (timestamp) values, the finalize step, as follows, computes these data:

```
finalizef = bson.Code('''function(key, value) {
    if(value.count > 0) {
       value.mean = value.total / value.count;
    }
    value.ts = new Date();
    return value;
}''')
```

With the above function the `map_reduce` operation itself will resemble the following:

```
cutoff = datetime.utcnow() - timedelta(seconds=60)
query = { 'ts': { '$gt': last_run, '$lt': cutoff } }

db.events.map_reduce(
    map=mapf_hour,
    reduce=reducef,
    finalize=finalizef,
    query=query,
    out={ 'reduce': 'stats.hourly' })

last_run = cutoff
```

The `cutoff` variable allows you to process all events that have occurred since the last run but before 1 minute ago. This allows for some delay in logging events. You can safely run this aggregation as often as you like, provided that you update the `last_run` variable each time.

Indexing

Create an index on the timestamp (i.e. the `ts` field) to support the query selection of the `map_reduce` operation. Use the following operation at the Python/PyMongo console:

```
>>> db.events.ensure_index('ts')
```

Deriving Day-Level Data

Aggregation

To calculate daily statistics, use the hourly statistics as input. Begin with the following map function:

```
mapf_day = bson.Code('''function() {
    var key = {
        u: this._id.u,
        d: new Date(
            this._id.d.getFullYear(),
            this._id.d.getMonth(),
            this._id.d.getDate(),
            0, 0, 0, 0) };
    emit(
        key,
        {
            total: this.value.total,
            count: this.value.count,
            mean: 0,
            ts: null });
}''')
```

The map function for deriving day-level data differs from the initial aggregation above in the following ways:

- the aggregation key is the (userid, date) rather than (userid, hour) to support daily aggregation.
- the keys and values emitted (i.e. `emit()`) are actually the total and count values from the hourly aggregates rather than properties from event documents.

  This is the case for all the higher-level aggregation operations.

Because the output of this map function is the same as the previous map function, you can use the same reduce and finalize functions.

The actual code driving this level of aggregation is as follows:

```
cutoff = datetime.utcnow() - timedelta(seconds=60)
query = { 'value.ts': { '$gt': last_run, '$lt': cutoff } }

db.stats.hourly.map_reduce(
    map=mapf_day,
    reduce=reducef,
    finalize=finalizef,
    query=query,
    out={ 'reduce': 'stats.daily' })

last_run = cutoff
```

There are a couple of things to note here. First of all, the query is not on `ts` now, but `value.ts`, the timestamp written during the finalization of the hourly aggregates. Also note that you are, in fact, aggregating from the `stats.hourly` collection into the `stats.daily` collection.

Indexing

Because you will run the query option regularly which finds on the `value.ts` field, you may wish to create an index to support this. Use the following operation in the Python/PyMongo shell to create this index:

```
>>> db.stats.hourly.ensure_index('value.ts')
```

Weekly and Monthly Aggregation

Aggregation

You can use the aggregated day-level data to generate weekly and monthly statistics. A map function for generating weekly data follows:

```
mapf_week = bson.Code('''function() {
    var key = {
        u: this._id.u,
        d: new Date(
            this._id.d.valueOf()
            - dt.getDay()*24*60*60*1000) };
    emit(
        key,
        {
            total: this.value.total,
            count: this.value.count,
            mean: 0,
            ts: null });
}''')
```

Here, to get the group key, the function takes the current and subtracts days until you get the beginning of the week. In the weekly map function, you'll use the first day of the month as the group key, as follows:

```
mapf_month = bson.Code('''function() {
        d: new Date(
            this._id.d.getFullYear(),
            this._id.d.getMonth(),
            1, 0, 0, 0, 0) };
    emit(
        key,
        {
            total: this.value.total,
            count: this.value.count,
            mean: 0,
            ts: null });
}''')
```

These map functions are identical to each other except for the date calculation.

Indexing

Create additional indexes to support the weekly and monthly aggregation options on the `value.ts` field. Use the following operation in the Python/PyMongo shell.

```
>>> db.stats.daily.ensure_index('value.ts')
>>> db.stats.monthly.ensure_index('value.ts')
```

Refactor Map Functions

Use Python's string interpolation to refactor the map function definitions as follows:

```
mapf_hierarchical = '''function() {
    var key = {
        u: this._id.u,
        d: %s };
    emit(
        key,
        {
            total: this.value.total,
            count: this.value.count,
            mean: 0,
            ts: null });
}'''

mapf_day = bson.Code(
    mapf_hierarchical % '''new Date(
            this._id.d.getFullYear(),
            this._id.d.getMonth(),
            this._id.d.getDate(),
            0, 0, 0, 0)''')

mapf_week = bson.Code(
    mapf_hierarchical % '''new Date(
            this._id.d.valueOf()
            - dt.getDay()*24*60*60*1000)''')

mapf_month = bson.Code(
    mapf_hierarchical % '''new Date(
            this._id.d.getFullYear(),
            this._id.d.getMonth(),
            1, 0, 0, 0, 0)''')

mapf_year = bson.Code(
    mapf_hierarchical % '''new Date(
            this._id.d.getFullYear(),
            1, 1, 0, 0, 0, 0)''')
```

You can create a `h_aggregate` function to wrap the `map_reduce` operation, as below, to reduce code duplication:

```
def h_aggregate(icollection, ocollection, mapf, cutoff, last_run):
     query = { 'value.ts': { '$gt': last_run, '$lt': cutoff } }
     icollection.map_reduce(
         map=mapf,
         reduce=reducef,
         finalize=finalizef,
         query=query,
         out={ 'reduce': ocollection.name })
```

With `h_aggregate` defined, you can perform all aggregation operations as follows:

```
cutoff = datetime.utcnow() - timedelta(seconds=60)

h_aggregate(db.events, db.stats.hourly, mapf_hour, cutoff, last_run)
h_aggregate(db.stats.hourly, db.stats.daily, mapf_day, cutoff, last_run)
h_aggregate(db.stats.daily, db.stats.weekly, mapf_week, cutoff, last_run)
h_aggregate(db.stats.daily, db.stats.monthly, mapf_month, cutoff, last_run)
```

```
h_aggregate(db.stats.monthly, db.stats.yearly, mapf_year, cutoff, last_run)

last_run = cutoff
```

As long as you save and restore the `last_run` variable between aggregations, you can run these aggregations as often as you like since each aggregation operation is incremental.

42.3.4 Sharding

Ensure that you choose a *shard key* that is not the incoming timestamp, but rather something that varies significantly in the most recent documents. In the example above, consider using the `userid` as the most significant part of the shard key.

To prevent a single, active user from creating a large, *chunk* that MongoDB cannot split, use a compound shard key with (username, timestamp) on the events collection. Consider the following:

```
>>> db.command('shardCollection','events', {
... 'key' : { 'userid': 1, 'ts' : 1} } )
{ "collectionsharded": "events", "ok" : 1 }
```

To shard the aggregated collections you must use the `_id` field, so you can issue the following group of shard operations in the Python/PyMongo shell:

```
db.command('shardCollection', 'stats.daily', {
     'key': { '_id': 1 } })
db.command('shardCollection', 'stats.weekly', {
     'key': { '_id': 1 } })
db.command('shardCollection', 'stats.monthly', {
     'key': { '_id': 1 } })
db.command('shardCollection', 'stats.yearly', {
     'key': { '_id': 1 } })
```

You should also update the `h_aggregate` map-reduce wrapper to support sharded output Add `'sharded':True` to the `out` argument. See the full sharded `h_aggregate` function:

```
def h_aggregate(icollection, ocollection, mapf, cutoff, last_run):
     query = { 'value.ts': { '$gt': last_run, '$lt': cutoff } }
     icollection.map_reduce(
         map=mapf,
         reduce=reducef,
         finalize=finalizef,
         query=query,
         out={ 'reduce': ocollection.name, 'sharded': True })
```

CHAPTER 43

Product Data Management

MongoDB's flexible schema makes it particularly well suited to storing information for product data management and e-commerce websites and solutions. The "*Product Catalog* (page 519)" document describes methods and practices for modeling and managing a product catalog using MongoDB, while the "*Inventory Management* (page 527)" document introduces a pattern for handling interactions between inventory and users' shopping carts. Finally the "*Category Hierarchy* (page 533)" document describes methods for interacting with category hierarchies in MongoDB.

43.1 Product Catalog

43.1.1 Overview

This document describes the basic patterns and principles for designing an E-Commerce product catalog system using MongoDB as a storage engine.

Problem

Product catalogs must have the capacity to store many differed types of objects with different sets of attributes. These kinds of data collections are quite compatible with MongoDB's data model, but many important considerations and design decisions remain.

Solution

For relational databases, there are several solutions that address this problem, each with a different performance profile. This section examines several of these options and then describes the preferred MongoDB solution.

SQL and Relational Data Models

Concrete Table Inheritance

One approach, in a relational model, is to create a table for each product category. Consider the following example SQL statement for creating database tables:

```
CREATE TABLE `product_audio_album` (
    `sku` char(8) NOT NULL,
    ...
    `artist` varchar(255) DEFAULT NULL,
    `genre_0` varchar(255) DEFAULT NULL,
    `genre_1` varchar(255) DEFAULT NULL,
    ...,
    PRIMARY KEY(`sku`))
...
CREATE TABLE `product_film` (
    `sku` char(8) NOT NULL,
    ...
    `title` varchar(255) DEFAULT NULL,
    `rating` char(8) DEFAULT NULL,
    ...,
    PRIMARY KEY(`sku`))
...
```

This approach has limited flexibility for two key reasons:

- You must create a new table for every new category of products.
- You must explicitly tailor all queries for the exact type of product.

Single Table Inheritance

Another relational data model uses a single table for all product categories and adds new columns anytime you need to store data regarding a new type of product. Consider the following SQL statement:

```
CREATE TABLE `product` (
    `sku` char(8) NOT NULL,
    ...
    `artist` varchar(255) DEFAULT NULL,
    `genre_0` varchar(255) DEFAULT NULL,
    `genre_1` varchar(255) DEFAULT NULL,
    ...
    `title` varchar(255) DEFAULT NULL,
    `rating` char(8) DEFAULT NULL,
    ...,
    PRIMARY KEY(`sku`))
```

This approach is more flexible than concrete table inheritance: it allows single queries to span different product types, but at the expense of space.

Multiple Table Inheritance

Also in the relational model, you may use a "multiple table inheritance" pattern to represent common attributes in a generic "product" table, with some variations in individual category product tables. Consider the following SQL statement:

```
CREATE TABLE `product` (
    `sku` char(8) NOT NULL,
    `title` varchar(255) DEFAULT NULL,
    `description` varchar(255) DEFAULT NULL,
    `price`, ...
    PRIMARY KEY(`sku`))
```

```
CREATE TABLE `product_audio_album` (
    `sku` char(8) NOT NULL,
    ...
    `artist` varchar(255) DEFAULT NULL,
    `genre_0` varchar(255) DEFAULT NULL,
    `genre_1` varchar(255) DEFAULT NULL,
    ...,
    PRIMARY KEY(`sku`),
    FOREIGN KEY(`sku`) REFERENCES `product`(`sku`))
...
CREATE TABLE `product_film` (
    `sku` char(8) NOT NULL,
    ...
    `title` varchar(255) DEFAULT NULL,
    `rating` char(8) DEFAULT NULL,
    ...,
    PRIMARY KEY(`sku`),
    FOREIGN KEY(`sku`) REFERENCES `product`(`sku`))
...
```

Multiple table inheritance is more space-efficient than *single table inheritance* (page 520) and somewhat more flexible than *concrete table inheritance* (page 520). However, this model does require an expensive `JOIN` operation to obtain all relevant attributes relevant to a product.

Entity Attribute Values

The final substantive pattern from relational modeling is the entity-attribute-value schema where you would create a meta-model for product data. In this approach, you maintain a table with three columns, e.g. `entity_id`, `attribute_id`, `value`, and these triples describe each product.

Consider the description of an audio recording. You may have a series of rows representing the following relationships:

Entity	Attribute	Value
sku_00e8da9b	type	Audio Album
sku_00e8da9b	title	A Love Supreme
sku_00e8da9b	...	...
sku_00e8da9b	artist	John Coltrane
sku_00e8da9b	genre	Jazz
sku_00e8da9b	genre	General
...	...	...

This schema is totally flexible:

- any entity can have any set of any attributes.
- New product categories do not require *any* changes to the data model in the database.

The downside for these models, is that all nontrivial queries require large numbers of `JOIN` operations that results in large performance penalties.

Avoid Modeling Product Data

Additionally some e-commerce solutions with relational database systems avoid choosing one of the data models above, and serialize all of this data into a `BLOB` column. While simple, the details become difficult to access for search and sort.

Non-Relational Data Model

Because MongoDB is a non-relational database, the data model for your product catalog can benefit from this additional flexibility. The best models use a single MongoDB collection to store all the product data, which is similar to the *single table inheritance* (page 520) relational model. MongoDB's dynamic schema means that each *document* need not conform to the same schema. As a result, the document for each product only needs to contain attributes relevant to that product.

Schema

At the beginning of the document, the schema must contain general product information, to facilitate searches of the entire catalog. Then, a `details` sub-document that contains fields that vary between product types. Consider the following example document for an album product.

```
{
  sku: "00e8da9b",
  type: "Audio Album",
  title: "A Love Supreme",
  description: "by John Coltrane",
  asin: "B0000A118M",

  shipping: {
    weight: 6,
    dimensions: {
      width: 10,
      height: 10,
      depth: 1
    },
  },

  pricing: {
    list: 1200,
    retail: 1100,
    savings: 100,
    pct_savings: 8
  },

  details: {
    title: "A Love Supreme [Original Recording Reissued]",
    artist: "John Coltrane",
    genre: [ "Jazz", "General" ],
        ...
    tracks: [
      "A Love Supreme Part I: Acknowledgement",
      "A Love Supreme Part II - Resolution",
      "A Love Supreme, Part III: Pursuance",
      "A Love Supreme, Part IV-Psalm"
    ],
  },
}
```

A movie item would have the same fields for general product information, shipping, and pricing, but have different details sub-document. Consider the following:

```
{
  sku: "00e8da9d",
  type: "Film",
```

```
  ...,
  asin: "B000P0J0AQ",

  shipping: { ... },

  pricing: { ... },

  details: {
    title: "The Matrix",
    director: [ "Andy Wachowski", "Larry Wachowski" ],
    writer: [ "Andy Wachowski", "Larry Wachowski" ],
    ...,
    aspect_ratio: "1.66:1"
  },
}
```

Note: In MongoDB, you can have fields that hold multiple values (i.e. arrays) without any restrictions on the number of fields or values (as with `genre_0` and `genre_1`) and also without the need for a JOIN operation.

43.1.2 Operations

For most deployments the primary use of the product catalog is to perform search operations. This section provides an overview of various types of queries that may be useful for supporting an e-commerce site. All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose.

Find Albums by Genre and Sort by Year Produced

Querying

This query returns the documents for the products of a specific genre, sorted in reverse chronological order:

```
query = db.products.find({'type':'Audio Album',
                          'details.genre': 'jazz'})
query = query.sort([('details.issue_date', -1)])
```

Indexing

To support this query, create a compound index on all the properties used in the filter and in the sort:

```
db.products.ensure_index([
    ('type', 1),
    ('details.genre', 1),
    ('details.issue_date', -1)])
```

Note: The final component of the index is the sort field. This allows MongoDB to traverse the index in the sorted order to preclude a slow in-memory sort.

Find Products Sorted by Percentage Discount Descending

While most searches will be for a particular type of product (e.g album, movie, etc.,) in some situations you may want to return all products in a certain price range, or discount percentage.

Querying

To return this data use the pricing information that exists in all products to find the products with the highest percentage discount:

```
query = db.products.find( { 'pricing.pct_savings': {'$gt': 25 })
query = query.sort([('pricing.pct_savings', -1)])
```

Indexing

To support this type of query, you will want to create an index on the `pricing.pct_savings` field:

```
db.products.ensure_index('pricing.pct_savings')
```

Since MongoDB can read indexes in ascending or descending order, the order of the index does not matter.

Note: If you want to preform range queries (e.g. "return all products over $25") and then sort by another property like `pricing.retail`, MongoDB cannot use the index as effectively in this situation.

The field that you want to select a range, or perform sort operations, must be the *last* field in a compound index in order to avoid scanning an entire collection. Using different properties within a single combined range query and sort operation requires some scanning which will limit the speed of your query.

Find Movies Based on Staring Actor

Querying

Use the following query to select documents within the details of a specified product type (i.e. `Film`) of product (a movie) to find products that contain a certain value (i.e. a specific actor in the `details.actor` field,) with the results sorted by date descending:

```
query = db.products.find({'type': 'Film',
                          'details.actor': 'Keanu Reeves'})
query = query.sort([('details.issue_date', -1)])
```

Indexing

To support this query, you may want to create the following index.

```
db.products.ensure_index([
    ('type', 1),
    ('details.actor', 1),
    ('details.issue_date', -1)])
```

This index begins with the `type` field and then narrows by the other search field, where the final component of the index is the sort field to maximize index efficiency.

Find Movies with a Particular Word in the Title

Regardless of database engine, in order to retrieve this information the system will need to scan some number of documents or records to satisfy this query.

Querying

MongoDB supports regular expressions within queries. In Python, you can use the "`python:re`" module to construct the query:

```
import re
re_hacker = re.compile(r'.*hacker.*', re.IGNORECASE)

query = db.products.find({'type': 'Film', 'title': re_hacker})
query = query.sort([('details.issue_date', -1)])
```

MongoDB provides a special syntax for regular expression queries without the need for the `re` module. Consider the following alternative which is equivalent to the above example:

```
query = db.products.find({
    'type': 'Film',
    'title': {'$regex': '.*hacker.*', '$options':'i'}})
query = query.sort([('details.issue_date', -1)])
```

The `$options` (page 713) operator specifies a case insensitive match.

Indexing

The indexing strategy for these kinds of queries is different from previous attempts. Here, create an index on `{ type: 1, details.issue_date: -1, title: 1 }` using the following command at the Python/PyMongo console:

```
db.products.ensure_index([
    ('type', 1),
    ('details.issue_date', -1),
    ('title', 1)])
```

This index makes it possible to avoid scanning whole documents by using the index for scanning the title rather than forcing MongoDB to scan whole documents for the title field. Additionally, to support the sort on the `details.issue_date` field, by placing this field *before* the `title` field, ensures that the result set is already ordered before MongoDB filters title field.

43.1.3 Scaling

Sharding

Database performance for these kinds of deployments are dependent on indexes. You may use *sharding* to enhance performance by allowing MongoDB to keep larger portions of those indexes in RAM. In sharded configurations, select a *shard key* that allows `mongos` (page 905) to route queries directly to a single shard or small group of shards.

Since most of the queries in this system include the `type` field, include this in the shard key. Beyond this, the remainder of the shard key is difficult to predict without information about your database's actual activity and distribution. Consider that:

- `details.issue_date` would be a poor addition to the shard key because, although it appears in a number of queries, no query was were *selective* by this field.
- you should include one or more fields in the `detail` document that you query frequently, and a field that has quasi-random features, to prevent large unsplittable chunks.

In the following example, assume that the `details.genre` field is the second-most queried field after `type`. Enable sharding using the following `shardCollection` (page 794) operation at the Python/PyMongo console:

```
>>> db.command('shardCollection', 'product', {
...     key : { 'type': 1, 'details.genre' : 1, 'sku':1 } })
{ "collectionsharded" : "details.genre", "ok" : 1 }
```

Note: Even if you choose a "poor" shard key that requires `mongos` (page 905) to broadcast all to all shards, you will still see some benefits from sharding, because:

1. Sharding makes a larger amount of memory available to store indexes, and
2. MongoDB will parallelize queries across shards, reducing latency.

Read Preference

While *sharding* is the best way to scale operations, some data sets make it impossible to partition data so that `mongos` (page 905) can route queries to specific shards. In these situations `mongos` (page 905) sends the query to all shards and then combines the results before returning to the client.

In these situations, you can add additional read performance by allowing `mongos` (page 905) to read from the *secondary* instances in a *replica set* by configuring *read preference* in your client. Read preference is configurable on a per-connection or per-operation basis. In PyMongo, set the `read_preference` argument.

The `SECONDARY` property in the following example, permits reads from a *secondary* (as well as a primary) for the entire connection .

```
conn = pymongo.Connection(read_preference=pymongo.SECONDARY)
```

Conversely, the `SECONDARY_ONLY` read preference means that the client will only send read operation only to the secondary member

```
conn = pymongo.Connection(read_preference=pymongo.SECONDARY_ONLY)
```

You can also specify `read_preference` for specific queries, as follows:

```
results = db.product.find(..., read_preference=pymongo.SECONDARY)
```

or

```
results = db.product.find(..., read_preference=pymongo.SECONDARY_ONLY)
```

See Also:

"*Replica Set Read Preference* (page 306)."

43.2 Inventory Management

43.2.1 Overview

This case study provides an overview of practices and patterns for designing and developing the inventory management portions of an E-commerce application.

See Also:

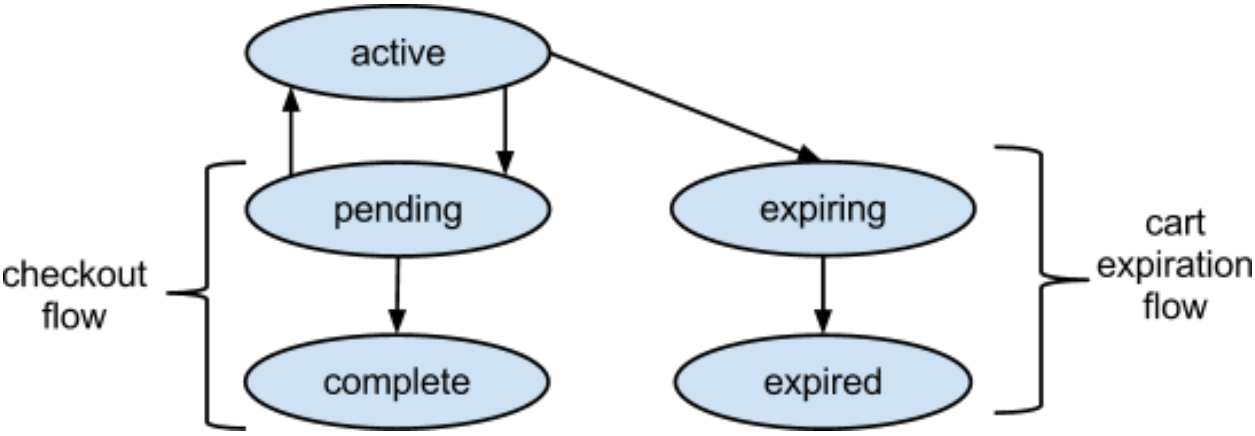
"*Product Catalog* (page 519)."

Problem

Customers in e-commerce stores regularly add and remove items from their "shopping cart," change quantities multiple times, abandon the cart at any point, and sometimes have problems during and after checkout that require a hold or canceled order. These activities make it difficult to maintain inventory systems and counts and ensure that customers cannot "buy" items that are unavailable while they shop in your store.

Solution

This solution keeps the traditional metaphor of the shopping cart, but the shopping cart will *age*. After a shopping cart has been inactive for a certain period of time, all items in the cart re-enter the available inventory and the cart is empty. The state transition diagram for a shopping cart is below:



Schema

Inventory collections must maintain counts of the current available inventory of each stock-keeping unit (SKU; or item) as well as a list of items in carts that may return to the available inventory if they are in a shopping cart that times out. In the following example, the `_id` field stores the SKU:

```
{
    _id: '00e8da9b',
    qty: 16,
    carted: [
        { qty: 1, cart_id: 42,
          timestamp: ISODate("2012-03-09T20:55:36Z"), },
        { qty: 2, cart_id: 43,
```

```
            timestamp: ISODate("2012-03-09T21:55:36Z"), },
    ]
}
```

Note: These examples use a simplified schema. In a production implementation, you may choose to merge this schema with the product catalog schema described in the "*Product Catalog* (page 519)" document.

The SKU above has 16 items in stock, 1 item a cart, and 2 items in a second cart. This leaves a total of 19 unsold items of merchandise.

To model the shopping cart objects, you need to maintain `sku`, `quantity`, fields embedded in a shopping cart *document*:

```
{
    _id: 42,
    last_modified: ISODate("2012-03-09T20:55:36Z"),
    status: 'active',
    items: [
        { sku: '00e8da9b', qty: 1, item_details: {...} },
        { sku: '0ab42f88', qty: 4, item_details: {...} }
    ]
}
```

Note: The `item_details` field in each line item allows your application to display the cart contents to the user without requiring a second query to fetch details from the catalog collection.

43.2.2 Operations

This section introduces operations that you may use to support an e-commerce site. All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose.

Add an Item to a Shopping Cart

Moving an item from the available inventory to a cart is a fundamental requirement for a shopping cart system. The most important requirement is to ensure that your application will never move an unavailable item from the inventory to the cart.

Ensure that inventory is only updated if there is sufficient inventory to satisfy the request with the following `add_item_to_cart` function operation.

```
def add_item_to_cart(cart_id, sku, qty, details):
    now = datetime.utcnow()

    # Make sure the cart is still active and add the line item
    result = db.cart.update(
        {'_id': cart_id, 'status': 'active' },
        { '$set': { 'last_modified': now },
          '$push': {
              'items': {'sku': sku, 'qty':qty, 'details': details } } },
        w=1)
    if not result['updatedExisting']:
        raise CartInactive()
```

```
    # Update the inventory
    result = db.inventory.update(
        {'_id':sku, 'qty': {'$gte': qty}},
        {'$inc': {'qty': -qty},
         '$push': {
             'carted': { 'qty': qty, 'cart_id':cart_id,
                         'timestamp': now } } },
        w=1)
    if not result['updatedExisting']:
        # Roll back our cart update
        db.cart.update(
            {'_id': cart_id },
            { '$pull': { 'items': {'sku': sku } } })
        raise InadequateInventory()
```

The system does not trust that the available inventory can satisfy a request

First this operation checks to make sure that the cart is "active" before adding a item. Then, it verifies that the available inventory to satisfy the request before decrementing inventory.

If there is not adequate inventory, the system removes the cart update: by specifying `w=1` and checking the result allows the application to report an error if the cart is inactive or available quantity is insufficient to satisfy the request.

Note: This operation requires no *indexes* beyond the default index on the `_id` field.

Modifying the Quantity in the Cart

The following process underlies adjusting the quantity of items in a users cart. The application must ensure that when a user increases the quantity of an item, in addition to updating the `carted` entry for the user's cart, that the inventory exists to cover the modification.

```
def update_quantity(cart_id, sku, old_qty, new_qty):
    now = datetime.utcnow()
    delta_qty = new_qty - old_qty

    # Make sure the cart is still active and add the line item
    result = db.cart.update(
        {'_id': cart_id, 'status': 'active', 'items.sku': sku },
        {'$set': {
             'last_modified': now,
             'items.$.qty': new_qty },
        },
        w=1)
    if not result['updatedExisting']:
        raise CartInactive()

    # Update the inventory
    result = db.inventory.update(
        {'_id':sku,
         'carted.cart_id': cart_id,
         'qty': {'$gte': delta_qty} },
        {'$inc': {'qty': -delta_qty },
         '$set': { 'carted.$.qty': new_qty, 'timestamp': now } },
        w=1)
```

```
    if not result['updatedExisting']:
        # Roll back our cart update
        db.cart.update(
            {'_id': cart_id, 'items.sku': sku },
            {'$set': { 'items.$.qty': old_qty } })
        raise InadequateInventory()
```

Note: That the positional operator `$` updates the particular `carted` entry and item that matched the query.

This allows the application to update the inventory and keep track of the data needed to "rollback" the cart in a single atomic operation. The code also ensures that the cart is active.

Note: This operation requires no *indexes* beyond the default index on the `_id` field.

Checking Out

The checkout operation must: validate the method of payment and remove the `carted` items after the transaction succeeds. Consider the following procedure:

```
def checkout(cart_id):
    now = datetime.utcnow()

    # Make sure the cart is still active and set to 'pending'. Also
    #     fetch the cart details so we can calculate the checkout price
    cart = db.cart.find_and_modify(
        {'_id': cart_id, 'status': 'active' },
        update={'$set': { 'status': 'pending','last_modified': now } } )
    if cart is None:
        raise CartInactive()

    # Validate payment details; collect payment
    try:
        collect_payment(cart)
        db.cart.update(
            {'_id': cart_id },
            {'$set': { 'status': 'complete' } } )
        db.inventory.update(
            {'carted.cart_id': cart_id},
            {'$pull': {'cart_id': cart_id} },
            multi=True)
    except:
        db.cart.update(
            {'_id': cart_id },
            {'$set': { 'status': 'active' } } )
        raise
```

Begin by "locking" the cart by setting its status to "pending" Then the system will verify that the cart is still active and collect payment data. Then, the `findAndModify` (page 758) *command* makes it possible to update the cart atomically and return its details to capture payment information. Then:

- If the payment is successful, then the application will remove the `carted` items from the inventory documents and set the cart to `complete`.
- If payment is unsuccessful, the application will unlock the cart by setting its status to `active` and report a payment error.

Note: This operation requires no *indexes* beyond the default index on the `_id` field.

Returning Inventory from Timed-Out Carts

Process

Periodically, your application must "expire" inactive carts and return their items to available inventory. In the example that follows the variable `timeout` controls the length of time before a cart expires:

```
def expire_carts(timeout):
    now = datetime.utcnow()
    threshold = now - timedelta(seconds=timeout)

    # Lock and find all the expiring carts
    db.cart.update(
        {'status': 'active', 'last_modified': { '$lt': threshold } },
        {'$set': { 'status': 'expiring' } },
        multi=True )

    # Actually expire each cart
    for cart in db.cart.find({'status': 'expiring'}):

        # Return all line items to inventory
        for item in cart['items']:
            db.inventory.update(
                { '_id': item['sku'],
                  'carted.cart_id': cart['id'],
                  'carted.qty': item['qty']
                },
                {'$inc': { 'qty': item['qty'] },
                 '$pull': { 'carted': { 'cart_id': cart['id'] } } })

        db.cart.update(
            {'_id': cart['id'] },
            {'$set': { status': 'expired' })
```

This procedure:

1. finds all carts that are older than the `threshold` and are due for expiration.
2. for each "expiring" cart, return all items to the available inventory.
3. once the items return to the available inventory, set the `status` field to `expired`.

Indexing

To support returning inventory from timed-out cart, create an index to support queries on their `status` and `last_modified` fields. Use the following operations in the Python/PyMongo shell:

```
db.cart.ensure_index([('status', 1), ('last_modified', 1)])
```

Error Handling

The above operations do not account for one possible failure situation: if an exception occurs after updating the shopping cart but before updating the inventory collection. This would result in a shopping cart that may be absent or expired but items have not returned to available inventory.

To account for this case, your application will need a periodic cleanup operation that finds inventory items that have `carted` items and check that to ensure that they exist in a user's cart, and return them to available inventory if they do not.

```
def cleanup_inventory(timeout):
    now = datetime.utcnow()
    threshold = now - timedelta(seconds=timeout)

    # Find all the expiring carted items
    for item in db.inventory.find(
        {'carted.timestamp': {'$lt': threshold }}):

        # Find all the carted items that matched
        carted = dict(
                  (carted_item['cart_id'], carted_item)
                  for carted_item in item['carted']
                  if carted_item['timestamp'] < threshold)

        # First Pass: Find any carts that are active and refresh the carted items
        for cart in db.cart.find(
            { '_id': {'$in': carted.keys() },
            'status':'active'}):
            cart = carted[cart['_id']]

            db.inventory.update(
                { '_id': item['_id'],
                  'carted.cart_id': cart['_id'] },
                { '$set': {'carted.$.timestamp': now } })
            del carted[cart['_id']]

        # Second Pass: All the carted items left in the dict need to now be
        #    returned to inventory
        for cart_id, carted_item in carted.items():
            db.inventory.update(
                { '_id': item['_id'],
                  'carted.cart_id': cart_id,
                  'carted.qty': carted_item['qty'] },
                { '$inc': { 'qty': carted_item['qty'] },
                  '$pull': { 'carted': { 'cart_id': cart_id } } })
```

To summarize: This operation finds all "carted" items that have time stamps older than the threshold. Then, the process makes two passes over these items:

1. Of the items with time stamps older than the threshold, if the cart is still active, it resets the time stamp to maintain the carts.
2. Of the stale items that remain in inactive carts, the operation returns these items to the inventory.

Note: The function above is safe for use because it checks to ensure that the cart has expired before returning items from the cart to inventory. However, it could be long-running and slow other updates and queries.

Use judiciously.

43.2.3 Sharding

If you need to *shard* the data for this system, the `_id` field is an ideal *shard key* for both carts and products because most update operations use the `_id` field. This allows `mongos` (page 905) to route all updates that select on `_id` to a single `mongod` (page 897) process.

There are two drawbacks for using `_id` as a shard key:

- If the cart collection's `_id` is an incrementing value, all new carts end up on a single shard.

  You can mitigate this effect by choosing a random value upon the creation of a cart, such as a hash (i.e. MD5 or SHA-1) of an ObjectID, as the `_id`. The process for this operation would resemble the following:

  ```
  import hashlib
  import bson

  cart_id = bson.ObjectId()
  cart_id_hash = hashlib.md5(str(cart_id)).hexdigest()

  cart = { "_id": cart_id, "cart_hash": cart_id_hash }
  db.cart.insert(cart)
  ```

- Cart expiration and inventory adjustment requires update operations and queries to broadcast to all shards when using `_id` as a shard key.

  This may be less relevant as the expiration functions run relatively infrequently and you can queue them or artificially slow them down (as with judicious use of `sleep()`) to minimize server load.

Use the following commands in the Python/PyMongo console to shard the cart and inventory collections:

```
>>> db.command('shardCollection', 'inventory'
...            'key': { '_id': 1 } )
{ "collectionsharded" : "inventory", "ok" : 1 }
>>> db.command('shardCollection', 'cart')
...            'key': { '_id': 1 } )
{ "collectionsharded" : "cart", "ok" : 1 }
```

43.3 Category Hierarchy

43.3.1 Overview

This document provides the basic design for modeling a product hierarchy stored in MongoDB as well as a collection of common operations for interacting with this data that will help you begin to write an E-commerce product category hierarchy.

See Also:

"*Product Catalog* (page 519)"

Solution

To model a product category hierarchy, this solution keeps each category in its own document that also has a list of its ancestors or "parents." This document uses music genres as the basis of its examples:

Because these kinds of categories change infrequently, this model focuses on the operations needed to keep the hierarchy up-to-date rather than the performance profile of update operations.

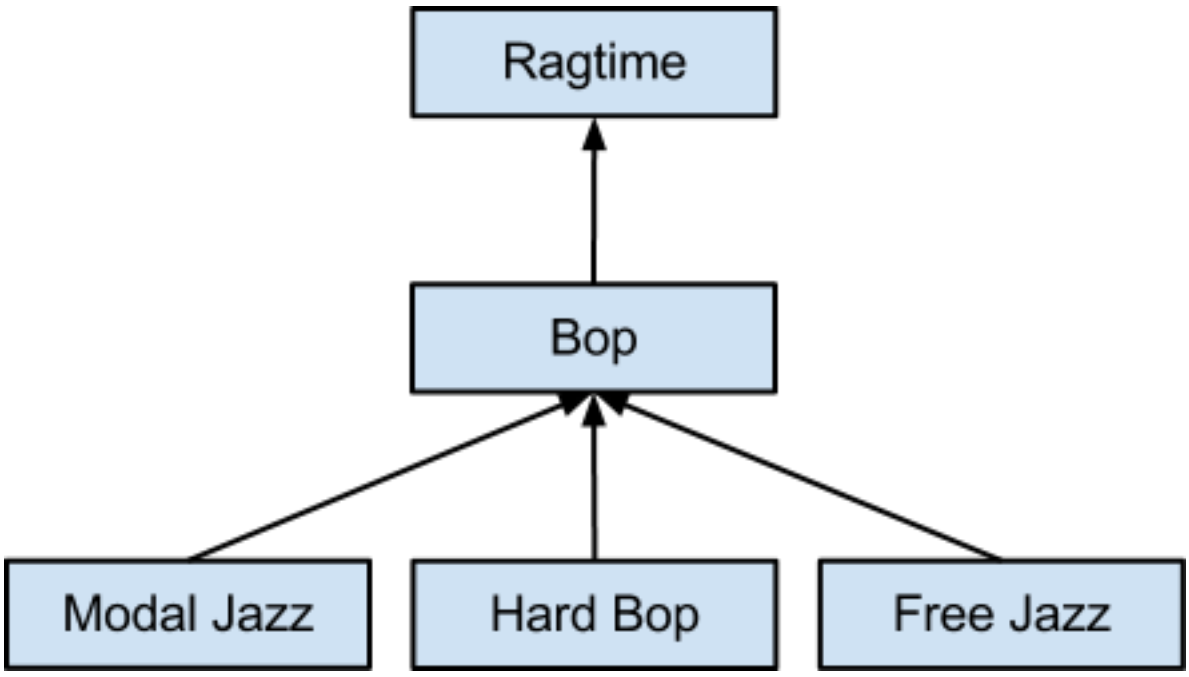


Figure 43.1: Initial category hierarchy

Schema

This schema has the following properties:

- A single document represents each category in the hierarchy.
- An `ObjectId` identifies each category document for internal cross-referencing.
- Each category document has a human-readable name and a URL compatible `slug` field.
- The schema stores a list of ancestors for each category to facilitate displaying a query and its ancestors using only a single query.

Consider the following prototype:

```
{ "_id" : ObjectId("4f5ec858eb03303a11000002"),
  "name" : "Modal Jazz",
  "parent" : ObjectId("4f5ec858eb03303a11000001"),
  "slug" : "modal-jazz",
  "ancestors" : [
         { "_id" : ObjectId("4f5ec858eb03303a11000001"),
        "slug" : "bop",
        "name" : "Bop" },
         { "_id" : ObjectId("4f5ec858eb03303a11000000"),
           "slug" : "ragtime",
           "name" : "Ragtime" } ]
}
```

43.3.2 Operations

This section outlines the category hierarchy manipulations that you may need in an E-Commerce site. All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement

this system using any language you choose.

Read and Display a Category

Querying

Use the following option to read and display a category hierarchy. This query will use the `slug` field to return the category information and a "bread crumb" trail from the current category to the top level category.

```
category = db.categories.find(
    {'slug':slug},
    {'_id':0, 'name':1, 'ancestors.slug':1, 'ancestors.name':1 })
```

Indexing

Create a unique index on the `slug` field with the following operation on the Python/PyMongo console:

```
>>> db.categories.ensure_index('slug', unique=True)
```

Add a Category to the Hierarchy

To add a category you must first determine its ancestors. Take adding a new category "Swing" as a child of "Ragtime", as below:

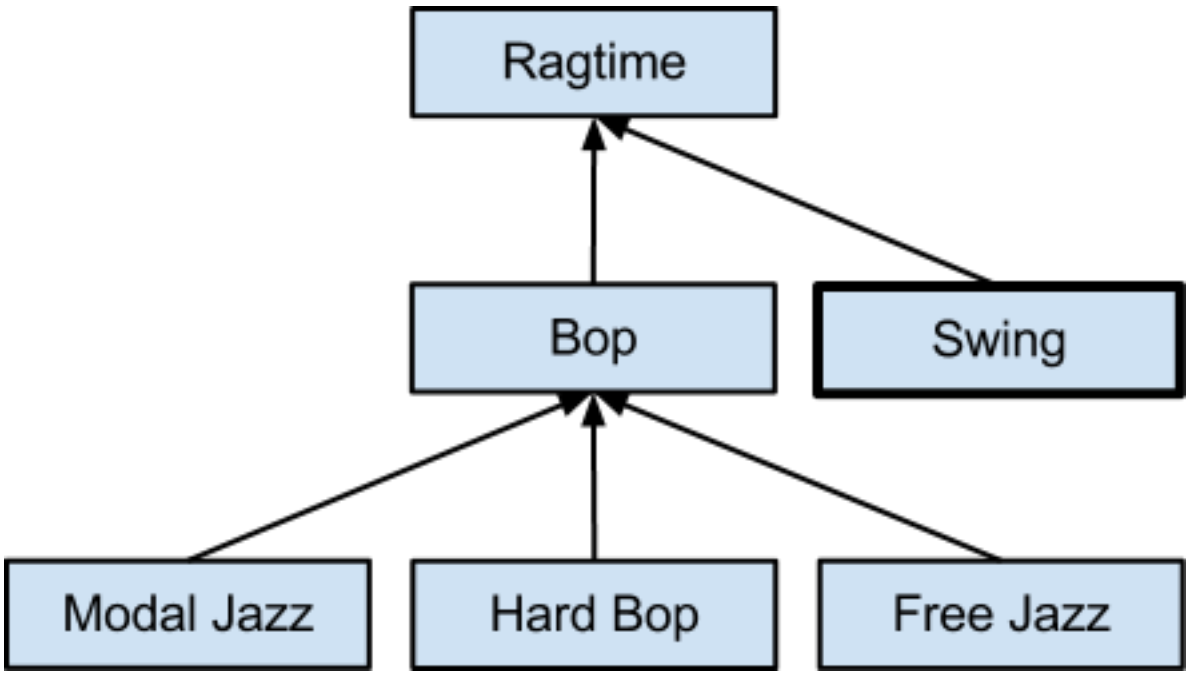


Figure 43.2: Adding a category

The insert operation would be trivial except for the ancestors. To define this array, consider the following helper function:

```
def build_ancestors(_id, parent_id):
    parent = db.categories.find_one(
        {'_id': parent_id},
        {'name': 1, 'slug': 1, 'ancestors':1})
    parent_ancestors = parent.pop('ancestors')
    ancestors = [ parent ] + parent_ancestors
    db.categories.update(
        {'_id': _id},
        {'$set': { 'ancestors': ancestors } })
```

You only need to travel "up" one level in the hierarchy to get the ancestor list for "Ragtime" that you can use to build the ancestor list for "Swing." Then create a document with the following set of operations:

```
doc = dict(name='Swing', slug='swing', parent=ragtime_id)
swing_id = db.categories.insert(doc)
build_ancestors(swing_id, ragtime_id)
```

Note: Since these queries and updates all selected based on `_id`, you only need the default MongoDB-supplied index on `_id` to support this operation efficiently.

Change the Ancestry of a Category

This section address the process for reorganizing the hierarchy by moving "bop" under "swing" as follows:

Procedure

Update the `bop` document to reflect the change in ancestry with the following operation:

```
db.categories.update(
    {'_id':bop_id}, {'$set': { 'parent': swing_id } } )
```

The following helper function, rebuilds the ancestor fields to ensure correctness. [1]

```
def build_ancestors_full(_id, parent_id):
    ancestors = []
    while parent_id is not None:
        parent = db.categories.find_one(
            {'_id': parent_id},
            {'parent': 1, 'name': 1, 'slug': 1, 'ancestors':1})
        parent_id = parent.pop('parent')
        ancestors.append(parent)
    db.categories.update(
        {'_id': _id},
        {'$set': { 'ancestors': ancestors } })
```

You can use the following loop to reconstruct all the descendants of the "bop" category:

```
for cat in db.categories.find(
    {'ancestors._id': bop_id},
    {'parent_id': 1}):
    build_ancestors_full(cat['_id'], cat['parent_id'])
```

[1] Your application cannot guarantee that the ancestor list of a parent category is correct, because MongoDB may process the categories out-of-order.

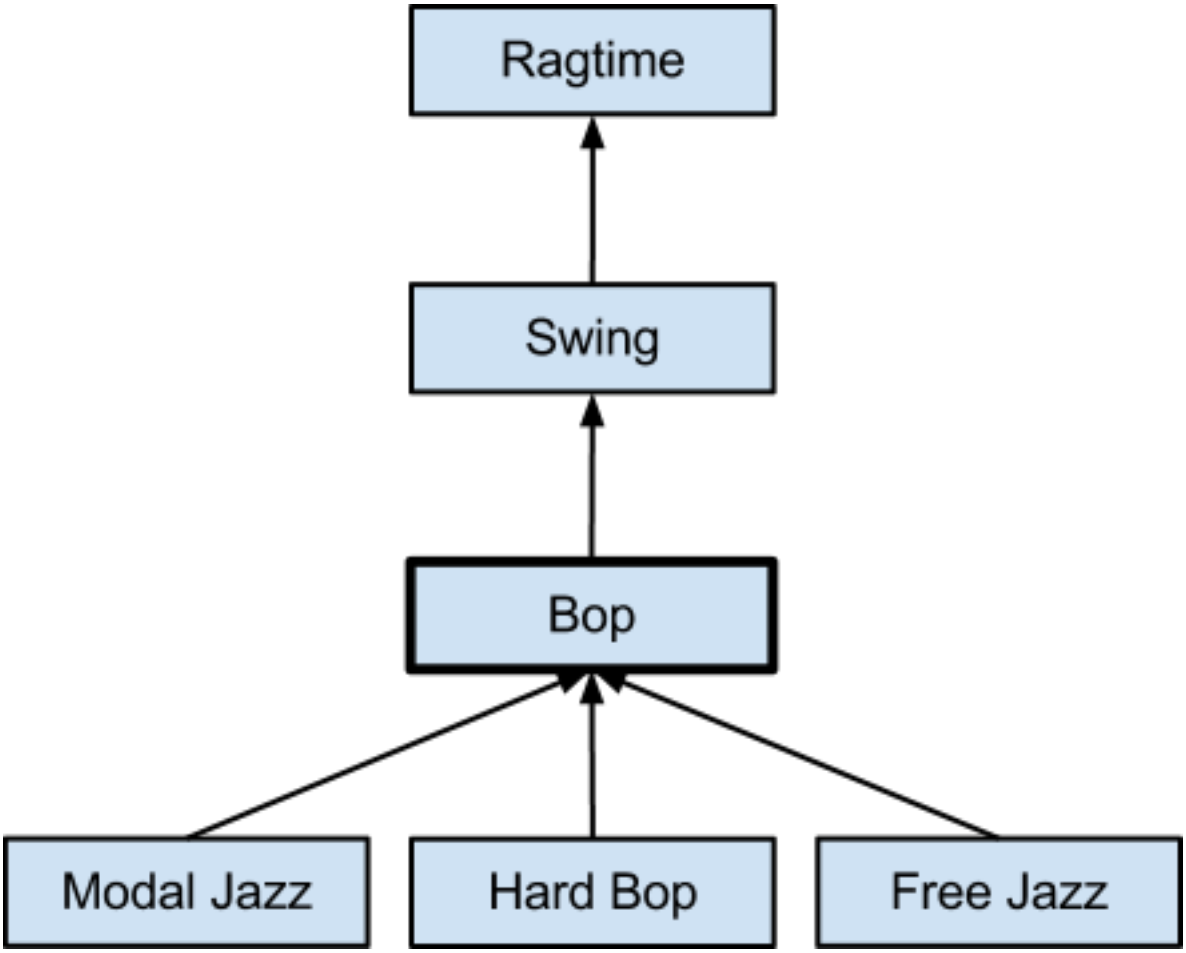


Figure 43.3: Change the parent of a category

Indexing

Create an index on the `ancestors._id` field to support the update operation.

```
db.categories.ensure_index('ancestors._id')
```

Rename a Category

To a rename a category you need to both update the category itself and also update all the descendants. Consider renaming "Bop" to "BeBop" as in the following figure:

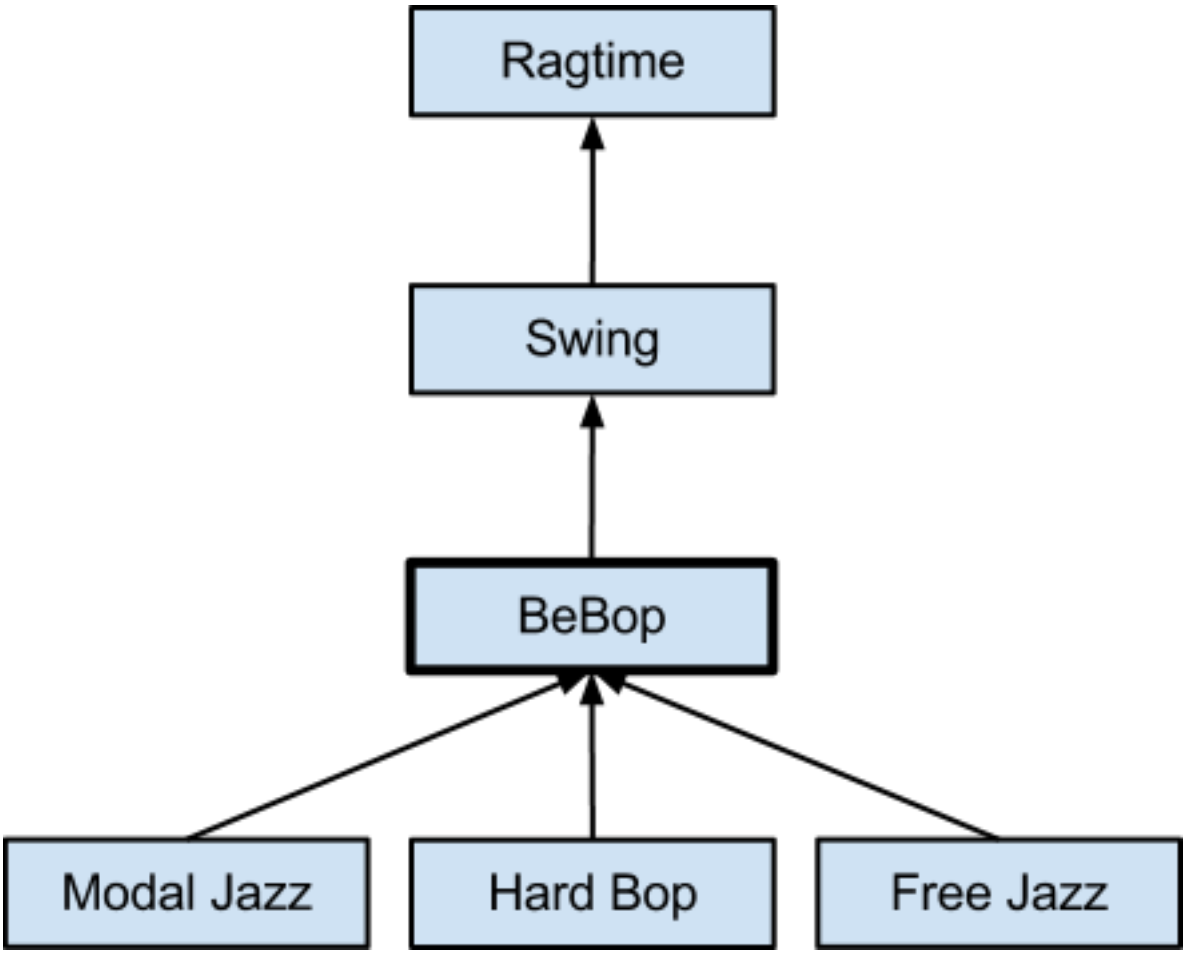


Figure 43.4: Rename a category

First, you need to update the category name with the following operation:

```
db.categories.update(
    {'_id':bop_id}, {'$set': { 'name': 'BeBop' } } )
```

Next, you need to update each descendant's ancestors list:

```
db.categories.update(
    {'ancestors._id': bop_id},
```

```
    {'$set': { 'ancestors.$.name': 'BeBop' } },
    multi=True)
```

This operation uses:

- the positional operation `$` to match the exact "ancestor" entry that matches the query, and
- the `multi` option to update all documents that match this query.

Note: In this case, the index you have already defined on `ancestors._id` is sufficient to ensure good performance.

43.3.3 Sharding

For most deployments, *sharding* this collection has limited value because the collection will be very small. If you do need to shard, because most updates query the `_id` field, this field is a suitable *shard key*. Shard the collection with the following operation in the Python/PyMongo console.

```
>>> db.command('shardCollection', 'categories', {
...     'key': {'_id': 1} })
{ "collectionsharded" : "categories", "ok" : 1 }
```

CHAPTER 44

Content Management Systems

The content management use cases introduce fundamental MongoDB practices and approaches, using familiar problems and simple examples. The "*Metadata and Asset Management* (page 541)" document introduces a model that you may use when designing a web site content management system, while "*Storing Comments* (page 548)" introduces the method for modeling user comments on content, like blog posts, and media, in MongoDB.

44.1 Metadata and Asset Management

44.1.1 Overview

This document describes the design and pattern of a content management system using MongoDB modeled on the popular Drupal CMS.

Problem

You are designing a content management system (CMS) and you want to use MongoDB to store the content of your sites.

Solution

To build this system you will use MongoDB's flexible schema to store all content "nodes" in a single collection regardless of type. This guide will provide prototype schema and describe common operations for the following primary node types:

Basic Page Basic pages are useful for displaying infrequently-changing text such as an 'about' page. With a basic page, the salient information is the title and the content.

Blog entry Blog entries record a "stream" of posts from users on the CMS and store title, author, content, and date as relevant information.

Photo Photos participate in photo galleries, and store title, description, author, and date along with the actual photo binary data.

This solution does not describe schema or process for storing or using navigational and organizational information.

Schema

Although *documents* in the `nodes` collection contain content of different types, all documents have a similar structure and a set of common fields. Consider the following prototype document for a "basic page" node type:

```
{
    _id: ObjectId(...),
    nonce: ObjectId(...),
    metadata: {
        type: 'basic-page'
        section: 'my-photos',
        slug: 'about',
        title: 'About Us',
        created: ISODate(...),
        author: { _id: ObjectId(...), name: 'Rick' },
        tags: [ ... ],
        detail: { text: '# About Us\n...' }
    }
}
```

Most fields are descriptively titled. The `section` field identifies groupings of items, as in a photo gallery, or a particular blog . The `slug` field holds a URL-friendly unique representation of the node, usually that is unique within its section for generating URLs.

All documents also have a `detail` field that varies with the document type. For the basic page above, the detail field might hold the text of the page. For a blog entry, the `detail` field might hold a sub-document. Consider the following prototype:

```
{
    ...
    metadata: {
        ...
        type: 'blog-entry',
        section: 'my-blog',
        slug: '2012-03-noticed-the-news',
        ...
        detail: {
            publish_on: ISODate(...),
            text: 'I noticed the news from Washington today...'
        }
    }
}
```

Photos require a different approach. Because photos can be potentially larger than these documents, it's important to separate the binary photo storage from the nodes metadata.

GridFS provides the ability to store larger files in MongoDB. GridFS stores data in two collections, in this case, `cms.assets.files`, which stores metadata, and `cms.assets.chunks` which stores the data itself. Consider the following prototype document from the `cms.assets.files` collection:

```
{
    _id: ObjectId(...),
    length: 123...,
    chunkSize: 262144,
    uploadDate: ISODate(...),
    contentType: 'image/jpeg',
    md5: 'ba49a...',
    metadata: {
        nonce: ObjectId(...),
```

```
        slug: '2012-03-invisible-bicycle',
        type: 'photo',
        section: 'my-album',
        title: 'Kitteh',
        created: ISODate(...),
        author: { _id: ObjectId(...), name: 'Jared' },
        tags: [ ... ],
        detail: {
            filename: 'kitteh_invisible_bike.jpg',
            resolution: [ 1600, 1600 ], ... }
    }
}
```

Note: This document embeds the basic node document fields, which allows you to use the same code to manipulate nodes, regardless of type.

44.1.2 Operations

This section outlines a number of common operations for building and interacting with the metadata and asset layer of the cms for all node types. All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose.

Create and Edit Content Nodes

Procedure

The most common operations inside of a CMS center on creating and editing content. Consider the following `insert()` operation:

```
db.cms.nodes.insert({
    'nonce': ObjectId(),
    'metadata': {
        'section': 'myblog',
        'slug': '2012-03-noticed-the-news',
        'type': 'blog-entry',
        'title': 'Noticed in the News',
        'created': datetime.utcnow(),
        'author': { 'id': user_id, 'name': 'Rick' },
        'tags': [ 'news', 'musings' ],
        'detail': {
            'publish_on': datetime.utcnow(),
            'text': 'I noticed the news from Washington today...' }
        }
     })
```

Once inserted, your application must have some way of preventing multiple concurrent updates. The schema uses the special `nonce` field to help detect concurrent edits. By using the `nonce` field in the query portion of the `update` operation, the application will generate an error if there is an editing collision. Consider the following `update`

```
def update_text(section, slug, nonce, text):
    result = db.cms.nodes.update(
        { 'metadata.section': section,
          'metadata.slug': slug,
          'nonce': nonce },
```

```
        { '$set':{'metadata.detail.text': text, 'nonce': ObjectId() } },
        w=1)
    if not result['updatedExisting']:
        raise ConflictError()
```

You may also want to perform metadata edits to the item such as adding tags:

```
db.cms.nodes.update(
    { 'metadata.section': section, 'metadata.slug': slug },
    { '$addToSet': { 'tags': { '$each': [ 'interesting', 'funny' ] } } })
```

In this example the `$addToSet` (page 691) operator will only add values to the `tags` field if they do not already exist in the `tags` array, there's no need to supply or update the nonce.

Index Support

To support updates and queries on the `metadata.section`, and `metadata.slug`, fields *and* to ensure that two editors don't create two documents with the same section name or slug. Use the following operation at the Python/PyMongo console:

```
>>> db.cms.nodes.ensure_index([
...     ('metadata.section', 1), ('metadata.slug', 1)], unique=True)
```

The `unique=True` option prevents to documents from colliding. If you want an index to support queries on the above fields and the `nonce` field create the following index:

```
>>> db.cms.nodes.ensure_index([
...     ('metadata.section', 1), ('metadata.slug', 1), ('nonce', 1) ])
```

However, in most cases, the first index will be sufficient to support these operations.

Upload a Photo

Procedure

To update a photo object, use the following operation, which builds upon the basic update procedure:

```
def upload_new_photo(
    input_file, section, slug, title, author, tags, details):
    fs = GridFS(db, 'cms.assets')
    with fs.new_file(
        content_type='image/jpeg',
        metadata=dict(
            type='photo',
            locked=datetime.utcnow(),
            section=section,
            slug=slug,
            title=title,
            created=datetime.utcnow(),
            author=author,
            tags=tags,
            detail=detail)) as upload_file:
        while True:
            chunk = input_file.read(upload_file.chunk_size)
            if not chunk: break
            upload_file.write(chunk)
```

```
    # unlock the file
    db.assets.files.update(
        {'_id': upload_file._id},
        {'$set': { 'locked': None } } )
```

Because uploading the photo spans multiple documents and is a non-atomic operation, you must "lock" the file during upload by writing `datetime.utcnow()` in the record. This helps when there are multiple concurrent editors and lets the application detect stalled file uploads. This operation assumes that, for photo upload, the last update will succeed:

```
def update_photo_content(input_file, section, slug):
    fs = GridFS(db, 'cms.assets')

    # Delete the old version if it's unlocked or was locked more than 5
    #    minutes ago
    file_obj = db.cms.assets.find_one(
        { 'metadata.section': section,
          'metadata.slug': slug,
          'metadata.locked': None })
    if file_obj is None:
        threshold = datetime.utcnow() - timedelta(seconds=300)
        file_obj = db.cms.assets.find_one(
            { 'metadata.section': section,
              'metadata.slug': slug,
              'metadata.locked': { '$lt': threshold } })
    if file_obj is None: raise FileDoesNotExist()
    fs.delete(file_obj['_id'])

    # update content, keep metadata unchanged
    file_obj['locked'] = datetime.utcnow()
    with fs.new_file(**file_obj):
        while True:
            chunk = input_file.read(upload_file.chunk_size)
            if not chunk: break
            upload_file.write(chunk)
    # unlock the file
    db.assets.files.update(
        {'_id': upload_file._id},
        {'$set': { 'locked': None } } )
```

As with the basic operations, you can use a much more simple operation to edit the tags:

```
db.cms.assets.files.update(
    { 'metadata.section': section, 'metadata.slug': slug },
    { '$addToSet': { 'metadata.tags': { '$each': [ 'interesting', 'funny' ] } } })
```

Index Support

Create a unique index on `{ metadata.section: 1, metadata.slug: 1 }` to support the above operations and prevent users from creating or updating the same file concurrently. Use the following operation in the Python/PyMongo console:

```
>>> db.cms.assets.files.ensure_index([
...     ('metadata.section', 1), ('metadata.slug', 1)], unique=True)
```

Locate and Render a Node

To locate a node based on the value of `metadata.section` and `metadata.slug`, use the following `find_one` operation.

```
node = db.nodes.find_one({'metadata.section': section, 'metadata.slug': slug })
```

Note: The index defined (`section`, `slug`) created to support the update operation, is sufficient to support this operation as well.

Locate and Render a Photo

To locate an image based on the value of `metadata.section` and `metadata.slug`, use the following `find_one` operation.

```
fs = GridFS(db, 'cms.assets')
with fs.get_version({'metadata.section': section, 'metadata.slug': slug }) as img_fpo:
    # do something with the image file
```

Note: The index defined (`section`, `slug`) created to support the update operation, is sufficient to support this operation as well.

Search for Nodes by Tag

Querying

To retrieve a list of nodes based on their tags, use the following query:

```
nodes = db.nodes.find({'metadata.tags': tag })
```

Indexing

Create an index on the `tags` field in the `cms.nodes` collection, to support this query:

```
>>> db.cms.nodes.ensure_index('tags')
```

Search for Images by Tag

Procedure

To retrieve a list of images based on their tags, use the following operation:

```
image_file_objects = db.cms.assets.files.find({'metadata.tags': tag })
fs = GridFS(db, 'cms.assets')
for image_file_object in db.cms.assets.files.find(
    {'metadata.tags': tag }):
    image_file = fs.get(image_file_object['_id'])
    # do something with the image file
```

Indexing

Create an index on the `tags` field in the `cms.assets.files` collection, to support this query:

```
>>> db.cms.assets.files.ensure_index('tags')
```

Generate a Feed of Recently Published Blog Articles

Querying

Use the following operation to generate a list of recent blog posts sorted in descending order by date, for use on the index page of your site, or in an `.rss` or `.atom` feed.

```
articles = db.nodes.find({
    'metadata.section': 'my-blog'
    'metadata.published': { '$lt': datetime.utcnow() } })
articles = articles.sort({'metadata.published': -1})
```

Note: In many cases you will want to limit the number of nodes returned by this query.

Indexing

Create a compound index on the `{ metadata.section: 1, metadata.published: 1 }` fields to support this query and sort operation.

```
>>> db.cms.nodes.ensure_index(
...     [ ('metadata.section', 1), ('metadata.published', -1) ])
```

Note: For all sort or range queries, ensure that field with the sort or range operation is the final field in the index.

44.1.3 Sharding

In a CMS, read performance is more critical than write performance. To achieve the best read performance in a *sharded cluster*, ensure that the `mongos` (page 905) can route queries to specific *shards*.

Also remember that MongoDB can not enforce unique indexes across shards. Using a compound *shard key* that consists of `metadata.section` and `metadata.slug`, will provide the same semantics as describe above.

Warning: Consider the actual use and workload of your cluster before configuring sharding for your cluster.

Use the following operation at the Python/PyMongo shell:

```
>>> db.command('shardCollection', 'cms.nodes', {
...     key : { 'metadata.section': 1, 'metadata.slug' : 1 } })
{ "collectionsharded": "cms.nodes", "ok": 1}
>>> db.command('shardCollection', 'cms.assets.files', {
...     key : { 'metadata.section': 1, 'metadata.slug' : 1 } })
{ "collectionsharded": "cms.assets.files", "ok": 1}
```

To shard the `cms.assets.chunks` collection, you must use the `_id` field as the *shard key*. The following operation will shard the collection

```
>>> db.command('shardCollection', 'cms.assets.chunks', {
...     key : { 'files_id': 1 } })
{ "collectionsharded": "cms.assets.chunks", "ok": 1}
```

Sharding on the `files_id` field ensures routable queries because all reads from GridFS must first look up the document in `cms.assets.files` and then look up the chunks separately.

44.2 Storing Comments

This document outlines the basic patterns for storing user-submitted comments in a content management system (CMS.)

44.2.1 Overview

MongoDB provides a number of different approaches for storing data like users-comments on content from a CMS. There is no correct implementation, but there are a number of common approaches and known considerations for each approach. This case study explores the implementation details and trade offs of each option. The three basic patterns are:

1. Store each comment in its own *document*.

   This approach provides the greatest flexibility at the expense of some additional application level complexity.

   These implementations make it possible to display comments in chronological or threaded order, and place no restrictions on the number of comments attached to a specific object.

2. Embed all comments in the "parent" document.

   This approach provides the greatest possible performance for displaying comments at the expense of flexibility: the structure of the comments in the document controls the display format.

   Note: Because of the *limit on document size* (page 1021), documents, including the original content and all comments, cannot grow beyond 16 megabytes.

   ---

3. A hybrid design, stores comments separately from the "parent," but aggregates comments into a small number of documents, where each contains many comments.

Also consider that comments can be *threaded*, where comments are always replies to "parent" item or to another comment, which carries certain architectural requirements discussed below.

44.2.2 One Document per Comment

Schema

If you store each comment in its own document, the documents in your `comments` collection, would have the following structure:

```
{
    _id: ObjectId(...),
    discussion_id: ObjectId(...),
    slug: '34db',
```

```
    posted: ISODateTime(...),
    author: {
              id: ObjectId(...),
              name: 'Rick'
            },
    text: 'This is so bogus ... '
}
```

This form is only suitable for displaying comments in chronological order. Comments store:

- the `discussion_id` field that references the discussion parent,
- a URL-compatible `slug` identifier,
- a `posted` timestamp,
- an `author` sub-document that contains a reference to a user's profile in the `id` field and their name in the `name` field, and
- the full `text` of the comment.

To support threaded comments, you might use a slightly different structure like the following:

```
{
    _id: ObjectId(...),
    discussion_id: ObjectId(...),
    parent_id: ObjectId(...),
    slug: '34db/8bda'
    full_slug: '2012.02.08.12.21.08:34db/2012.02.09.22.19.16:8bda',
    posted: ISODateTime(...),
    author: {
              id: ObjectId(...),
              name: 'Rick'
            },
    text: 'This is so bogus ... '
}
```

This structure:

- adds a `parent_id` field that stores the contents of the `_id` field of the parent comment,
- modifies the `slug` field to hold a path composed of the parent or parent's slug and this comment's unique slug, and
- adds a `full_slug` field that that combines the slugs and time information to make it easier to sort documents in a threaded discussion by date.

Warning: MongoDB can only index *1024 bytes* (page 1022). This includes all field data, the field name, and the namespace (i.e. database name and collection name.) This may become an issue when you create an index of the `full_slug` field to support sorting.

Operations

This section contains an overview of common operations for interacting with comments represented using a schema where each comment is its own *document*.

All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose. Issue the following commands at the interactive Python shell to load the required libraries:

```
>>> import bson
>>> import pymongo
```

Post a New Comment

To post a new comment in a chronologically ordered (i.e. without threading) system, use the following `insert()` operation:

```
slug = generate_pseudorandom_slug()
db.comments.insert({
    'discussion_id': discussion_id,
    'slug': slug,
    'posted': datetime.utcnow(),
    'author': author_info,
    'text': comment_text })
```

To insert a comment for a system with threaded comments, you must generate the `slug` path and `full_slug` at insert. See the following operation:

```
posted = datetime.utcnow()

# generate the unique portions of the slug and full_slug
slug_part = generate_pseudorandom_slug()
full_slug_part = posted.strftime('%Y.%m.%d.%H.%M.%S') + ':' + slug_part
# load the parent comment (if any)
if parent_slug:
    parent = db.comments.find_one(
        {'discussion_id': discussion_id, 'slug': parent_slug })
    slug = parent['slug'] + '/' + slug_part
    full_slug = parent['full_slug'] + '/' + full_slug_part
else:
    slug = slug_part
    full_slug = full_slug_part

# actually insert the comment
db.comments.insert({
    'discussion_id': discussion_id,
    'slug': slug,
    'full_slug': full_slug,
    'posted': posted,
    'author': author_info,
    'text': comment_text })
```

View Paginated Comments

To view comments that are not threaded, select all comments participating in a discussion and sort by the `posted` field. For example:

```
cursor = db.comments.find({'discussion_id': discussion_id})
cursor = cursor.sort('posted')
cursor = cursor.skip(page_num * page_size)
cursor = cursor.limit(page_size)
```

Because the `full_slug` field contains both hierarchical information (via the path) and chronological information, you can use a simple sort on the `full_slug` field to retrieve a threaded view:

```
cursor = db.comments.find({'discussion_id': discussion_id})
cursor = cursor.sort('full_slug')
cursor = cursor.skip(page_num * page_size)
cursor = cursor.limit(page_size)
```

See Also:

`cursor.limit` (page 807), `cursor.skip` (page 812), and `cursor.sort` (page 813)

Indexing

To support the above queries efficiently, maintain two compound indexes, on:

1. (``discussion_id, posted)`` and
2. (``discussion_id, full_slug)``

Issue the following operation at the interactive Python shell.

```
>>> db.comments.ensure_index([
...     ('discussion_id', 1), ('posted', 1)])
>>> db.comments.ensure_index([
...     ('discussion_id', 1), ('full_slug', 1)])
```

Note: Ensure that you always sort by the final element in a compound index to maximize the performance of these queries.

Retrieve Comments via Direct Links

Queries

To directly retrieve a comment, without needing to page through all comments, you can select by the `slug` field:

```
comment = db.comments.find_one({
    'discussion_id': discussion_id,
    'slug': comment_slug})
```

You can retrieve a "sub-discussion," or a comment and all of its descendants recursively, by performing a regular expression prefix query on the `full_slug` field:

```
import re

subdiscussion = db.comments.find_one({
    'discussion_id': discussion_id,
    'full_slug': re.compile('^' + re.escape(parent_slug)) })
subdiscussion = subdiscussion.sort('full_slug')
```

Indexing

Since you have already created indexes on `{ discussion_id: 1, full_slug: }` to support retrieving sub-discussions, you can add support for the above queries by adding an index on `{ discussion_id: 1 , slug: 1 }`. Use the following operation in the Python shell:

```
>>> db.comments.ensure_index([
...     ('discussion_id', 1), ('slug', 1)])
```

44.2.3 Embedding All Comments

This design embeds the entire discussion of a comment thread inside of the topic *document*. In this example, the "topic," document holds the total content for whatever content you're managing.

Schema

Consider the following prototype `topic` document:

```
{
    _id: ObjectId(...),
    ... lots of topic data ...
    comments: [
        { posted: ISODateTime(...),
          author: { id: ObjectId(...), name: 'Rick' },
          text: 'This is so bogus ... ' },
       ... ]
}
```

This structure is only suitable for a chronological display of all comments because it embeds comments in chronological order. Each document in the array in the `comments` contains the comment's date, author, and text.

Note: Since you're storing the comments in sorted order, there is no need to maintain per-comment slugs.

To support threading using this design, you would need to embed comments within comments, using a structure that resembles the following:

```
{
    _id: ObjectId(...),
    ... lots of topic data ...
    replies: [
        { posted: ISODateTime(...),
          author: { id: ObjectId(...), name: 'Rick' },
          text: 'This is so bogus ... ',
          replies: [
              { author: { ... }, ... },
       ... ]
}
```

Here, the `replies` field in each comment holds the sub-comments, which can intern hold sub-comments.

Note: In the embedded document design, you give up some flexibility regarding display format, because it is difficult to display comments *except* as you store them in MongoDB.

If, in the future, you want to switch from chronological to threaded or from threaded to chronological, this design would make that migration quite expensive.

Warning: Remember that *BSON* documents have a *16 megabyte size limit* (page 1021). If popular discussions grow larger than 16 megabytes, additional document growth will fail.
Additionally, when MongoDB documents grow significantly after creation you will experience greater storage fragmentation and degraded update performance while MongoDB migrates documents internally.

Operations

This section contains an overview of common operations for interacting with comments represented using a schema that embeds all comments the *document* of the "parent" or topic content.

Note: For all operations below, there is no need for any new indexes since all the operations are function within documents. Because you would retrieve these documents by the `_id` field, you can rely on the index that MongoDB creates automatically.

Post a new comment

To post a new comment in a chronologically ordered (i.e unthreaded) system, you need the following `update()`:

```
db.discussion.update(
    { 'discussion_id': discussion_id },
    { '$push': { 'comments': {
        'posted': datetime.utcnow(),
        'author': author_info,
        'text': comment_text } } } )
```

The `$push` (page 711) operator inserts comments into the `comments` array in correct chronological order. For threaded discussions, the `update()` operation is more complex. To reply to a comment, the following code assumes that it can retrieve the 'path' as a list of positions, for the parent comment:

```
if path != []:
    str_path = '.'.join('replies.%d' % part for part in path)
    str_path += '.replies'
else:
    str_path = 'replies'
db.discussion.update(
    { 'discussion_id': discussion_id },
    { '$push': {
        str_path: {
            'posted': datetime.utcnow(),
            'author': author_info,
            'text': comment_text } } } )
```

This constructs a field name of the form `replies.0.replies.2...` as `str_path` and then uses this value with the `$push` (page 711) operator to insert the new comment into the parent comment's `replies` array.

View Paginated Comments

To view the comments in a non-threaded design, you must use the `$slice` operator:

```
discussion = db.discussion.find_one(
    {'discussion_id': discussion_id},
    { ... some fields relevant to your page from the root discussion ...,
```

```
      'comments': { '$slice': [ page_num * page_size, page_size ] }
    })
```

To return paginated comments for the threaded design, you must retrieve the whole document and paginate the comments within the application:

```
discussion = db.discussion.find_one({'discussion_id': discussion_id})

def iter_comments(obj):
    for reply in obj['replies']:
        yield reply
        for subreply in iter_comments(reply):
            yield subreply

paginated_comments = itertools.slice(
    iter_comments(discussion),
    page_size * page_num,
    page_size * (page_num + 1))
```

Retrieve a Comment via Direct Links

Instead of retrieving comments via slugs as above, the following example retrieves comments using their position in the comment list or tree.

For chronological (i.e. non-threaded) comments, just use the `$slice` operator to extract a comment, as follows:

```
discussion = db.discussion.find_one(
    {'discussion_id': discussion_id},
    {'comments': { '$slice': [ position, position ] } })
comment = discussion['comments'][0]
```

For threaded comments, you must find the correct path through the tree in your application, as follows:

```
discussion = db.discussion.find_one({'discussion_id': discussion_id})
current = discussion
for part in path:
    current = current.replies[part]
comment = current
```

Note: Since parent comments embed child replies, this operation actually retrieves the entire sub-discussion for the comment you queried for.

See Also:

`find_one()`.

44.2.4 Hybrid Schema Design

Schema

In the "hybrid approach" you will store comments in "buckets" that hold about 100 comments. Consider the following example document:

```
{
    _id: ObjectId(...),
    discussion_id: ObjectId(...),
    page: 1,
    count: 42,
    comments: [ {
        slug: '34db',
        posted: ISODateTime(...),
        author: { id: ObjectId(...), name: 'Rick' },
        text: 'This is so bogus ... ' },
    ... ]
}
```

Each document maintains `page` and `count` data that contains meta data regarding the page, the page number and the comment count, in addition to the `comments` array that holds the comments themselves.

Note: Using a hybrid format makes storing threaded comments complex, and this specific configuration is not covered in this document.

Also, 100 comments is a *soft* limit for the number of comments per page. This value is arbitrary: choose a value that will prevent the maximum document size from growing beyond the 16MB *BSON document size limit* (page 1021), but large enough to ensure that most comment threads will fit in a single document. In some situations the number of comments per document can exceed 100, but this does not affect the correctness of the pattern.

Operations

This section contains a number of common operations that you may use when building a CMS using this hybrid storage model with documents that hold 100 comment "pages."

All examples in this document use the Python programming language and the PyMongo *driver* for MongoDB, but you can implement this system using any language you choose.

Post a New Comment

Updating In order to post a new comment, you need to `$push` (page 711) the comment onto the last page and `$inc` (page 699) that page's comment count. Consider the following example that queries on the basis of a `discussion_id` field:

```
page = db.comment_pages.find_and_modify(
    { 'discussion_id': discussion['_id'],
      'page': discussion['num_pages'] },
    { '$inc': { 'count': 1 },
      '$push': {
          'comments': { 'slug': slug, ... } } },
    fields={'count':1},
    upsert=True,
    new=True )
```

The `find_and_modify()` operation is an *upsert*,: if MongoDB cannot find a document with the correct `page` number, the `find_and_modify()` will create it and initialize the new document with appropriate values for `count` and `comments`.

To limit the number of comments per page to roughly 100, you will need to create new pages as they become necessary. Add the following logic to support this:

```
if page['count'] > 100:
    db.discussion.update(
        { 'discussion_id: discussion['_id'],
          'num_pages': discussion['num_pages'] },
        { '$inc': { 'num_pages': 1 } } )
```

This `update()` operation includes the last known number of pages in the query to prevent a race condition where the number of pages increments twice, that would result in a nearly or totally empty document. If another process increments the number of pages, then update above does nothing.

Indexing To support the `find_and_modify()` and `update()` operations, maintain a compound index on (`discussion_id`, `page`) in the `comment_pages` collection, by issuing the following operation at the Python/PyMongo console:

```
>>> db.comment_pages.ensure_index([
...     ('discussion_id', 1), ('page', 1)])
```

View Paginated Comments

The following function defines how to paginate comments with a *fixed* page size (i.e. not with the roughly 100 comment documents in the above example,) as en example:

```
def find_comments(discussion_id, skip, limit):
    result = []
    page_query = db.comment_pages.find(
        { 'discussion_id': discussion_id },
        { 'count': 1, 'comments': { '$slice': [ skip, limit ] } })
    page_query = page_query.sort('page')
    for page in page_query:
        result += page['comments']
        skip = max(0, skip - page['count'])
        limit -= len(page['comments'])
        if limit == 0: break
    return result
```

Here, the `$slice` operator pulls out comments from each page, but *only* when this satisfies the `skip` requirement. For example: if you have 3 pages with 100, 102, 101, and 22 comments on each page, and you wish to retrieve comments where `skip=300` and `limit=50`. Use the following algorithm:

Skip	Limit	Discussion
300	50	`{$slice: [ 300, 50 ] }` matches nothing in page #1; subtract page #1's `count` from `skip` and continue.
200	50	`{$slice: [ 200, 50 ] }` matches nothing in page #2; subtract page #2's `count` from `skip` and continue.
98	50	`{$slice: [ 98, 50 ] }` matches 2 comments in page #3; subtract page #3's `count` from `skip` (saturating at 0), subtract 2 from limit, and continue.
0	48	`{$slice: [ 0, 48 ] }` matches all 22 comments in page #4; subtract 22 from `limit` and continue.
0	26	There are no more pages; terminate loop.

Note: Since you already have an index on (`discussion_id`, `page`) in your `comment_pages` collection, MongoDB can satisfy these queries efficiently.

Retrieve a Comment via Direct Links

Query To retrieve a comment directly without paging through all preceding pages of commentary, use the slug to find the correct page, and then use application logic to find the correct comment:

```
page = db.comment_pages.find_one(
    { 'discussion_id': discussion_id,
      'comments.slug': comment_slug},
    { 'comments': 1 })
for comment in page['comments']:
    if comment['slug'] = comment_slug:
        break
```

Indexing To perform this query efficiently you'll need a new index on the `discussion_id` and `comments.slug` fields (i.e. `{ discussion_id: 1 comments.slug: 1 }`.) Create this index using the following operation in the Python/PyMongo console:

```
>>> db.comment_pages.ensure_index([
...     ('discussion_id', 1), ('comments.slug', 1)])
```

44.2.5 Sharding

For all of the architectures discussed above, you will want to the `discussion_id` field to participate in the shard key, if you need to shard your application.

For applications that use the "one document per comment" approach, consider using `slug` (or `full_slug`, in the case of threaded comments) fields in the shard key to allow the `mongos` (page 905) instances to route requests by `slug`. Issue the following operation at the Python/PyMongo console:

```
>>> db.command('shardCollection', 'comments', {
...     'key' : { 'discussion_id' : 1, 'full_slug': 1 } })
```

This will return the following response:

```
{ "collectionsharded" : "comments", "ok" : 1 }
```

In the case of comments that fully-embedded in parent content *documents* the determination of the shard key is outside of the scope of this document.

For hybrid documents, use the page number of the comment page in the shard key along with the `discussion_id` to allow MongoDB to split popular discussions between, while grouping discussions on the same shard. Issue the following operation at the Python/PyMongo console:

```
>>> db.command('shardCollection', 'comment_pages', {
...     key : { 'discussion_id' : 1, 'page': 1 } })
{ "collectionsharded" : "comment_pages", "ok" : 1 }
```

CHAPTER 45

Python Application Development

45.1 Write a Tumblelog Application with Django MongoDB Engine

45.1.1 Introduction

In this tutorial, you will learn how to create a basic tumblelog application using the popular Django Python web-framework and the *MongoDB* database.

The tumblelog will consist of two parts:

1. A public site that lets people view posts and comment on them.
2. An admin site that lets you add, change and delete posts and publish comments.

This tutorial assumes that you are already familiar with Django and have a basic familiarity with MongoDB operation and have *installed MongoDB* (page 3).

Where to get help

If you're having trouble going through this tutorial, please post a message to mongodb-user or join the IRC chat in *#mongodb* on irc.freenode.net to chat with other MongoDB users who might be able to help.

Note: Django MongoDB Engine uses a forked version of Django 1.3 that adds non-relational support.

45.1.2 Installation

Begin by installing packages required by later steps in this tutorial.

Prerequisite

This tutorial uses pip to install packages and virtualenv to isolate Python environments. While these tools and this configuration are not required as such, they ensure a standard environment and are strongly recommended. Issue the following commands at the system prompt:

```
pip install virtualenv
virtualenv myproject
```

Respectively, these commands: install the `virtualenv` program (using `pip`) and create a isolated python environment for this project (named `myproject`.)

To activate `myproject` environment at the system prompt, use the following commands:

```
source myproject/bin/activate
```

Installing Packages

Django MongoDB Engine directly depends on:

- Django-nonrel, a fork of Django 1.3 that adds support for non-relational databases
- djangotoolbox, a bunch of utilities for non-relational Django applications and backends

Install by issuing the following commands:

```
pip install https://bitbucket.org/wkornewald/django-nonrel/get/tip.tar.gz
pip install https://bitbucket.org/wkornewald/djangotoolbox/get/tip.tar.gz
pip install https://github.com/django-nonrel/mongodb-engine/tarball/master
```

Continue with the tutorial to begin building the "tumblelog" application.

45.1.3 Build a Blog to Get Started

In this tutorial you will build a basic blog as the foundation of this application and use this as the basis of your tumblelog application. You will add the first post using the shell and then later use the Django administrative interface.

Call the `startproject` command, as with other Django projects, to get started and create the basic project skeleton:

```
django-admin.py startproject tumblelog
```

Configuring Django

Configure the database in the `tumblelog/settings.py` file:

```
DATABASES = {
   'default': {
      'ENGINE': 'django_mongodb_engine',
      'NAME': 'my_tumble_log'
   }
}
```

See Also:

The Django MongoDB Engine Settings documentation for more configuration options.

Define the Schema

The first step in writing a tumblelog in Django is to define the "models" or in MongoDB's terminology *documents*.

In this application, you will define posts and comments, so that each `Post` can contain a list of `Comments`. Edit the `tumblelog/models.py` file so it resembles the following:

```
from django.db import models
from django.core.urlresolvers import reverse

from djangotoolbox.fields import ListField, EmbeddedModelField


class Post(models.Model):
    created_at = models.DateTimeField(auto_now_add=True, db_index=True)
    title = models.CharField(max_length=255)
    slug = models.SlugField()
    body = models.TextField()
    comments = ListField(EmbeddedModelField('Comment'), editable=False)

    def get_absolute_url(self):
        return reverse('post', kwargs={"slug": self.slug})

    def __unicode__(self):
        return self.title

    class Meta:
        ordering = ["-created_at"]


class Comment(models.Model):
    created_at = models.DateTimeField(auto_now_add=True)
    body = models.TextField(verbose_name="Comment")
    author = models.CharField(verbose_name="Name", max_length=255)
```

The Django "nonrel" code looks the same as vanilla Django, however there is no built in support for some of MongoDB's native data types like Lists and Embedded data. `djangotoolbox` handles these definitions.

See Also:

The Django MongoDB Engine fields documentation for more.

The models declare an index to the `Post` class. One for the `created_at` date as our frontpage will order by date: there is no need to add `db_index` on `SlugField` because there is a default index on `SlugField`.

Add Data with the Shell

The `manage.py` provides a shell interface for the application that you can use to insert data into the tumblelog. Begin by issuing the following command to load the Python shell:

```
python manage.py shell
```

Create the first post using the following sequence of operations:

```
>>> from tumblelog.models import *
>>> post = Post(
... title="Hello World!",
... slug="hello-world",
... body = "Welcome to my new shiny Tumble log powered by MongoDB and Django-MongoDB!"
... )
>>> post.save()
```

Add comments using the following sequence of operations:

```
>>> post.comments
[]
```

```
>>> comment = Comment(
... author="Joe Bloggs",
... body="Great post! I'm looking forward to reading your blog")
>>> post.comments.append(comment)
>>> post.save()
```

Finally, inspect the post:

```
>>> post = Post.objects.get()
>>> post
<Post: Hello World!>
>>> post.comments
[<Comment: Comment object>]
```

Add the Views

Because django-mongodb provides tight integration with Django you can use generic views to display the frontpage and post pages for the tumblelog. Insert the following content into the `urls.py` file to add the views:

```
from django.conf.urls.defaults import patterns, include, url
from django.views.generic import ListView, DetailView
from tumblelog.models import Post

urlpatterns = patterns('',
    url(r'^$', ListView.as_view(
        queryset=Post.objects.all(),
        context_object_name="posts_list"),
        name="home"
    ),
    url(r'^post/(?P<slug>[a-zA-Z0-9-]+)/$', DetailView.as_view(
        queryset=Post.objects.all(),
        context_object_name="post"),
        name="post"
    ),
)
```

Add Templates

In the tumblelog directory add the following directories `templates` and `templates/tumblelog` for storing the tumblelog templates:

```
mkdir -p templates/tumblelog
```

Configure Django so it can find the templates by updating `TEMPLATE_DIRS` in the `settings.py` file to the following:

```
import os.path
TEMPLATE_DIRS = (
    os.path.join(os.path.realpath(__file__), '../templates'),
)
```

Then add a base template that all others can inherit from. Add the following to `templates/base.html`:

```
<!DOCTYPE html>
<html lang="en">
  <head>
```

```
    <meta charset="utf-8">
    <title>My Tumblelog</title>
    <link href="http://twitter.github.com/bootstrap/1.4.0/bootstrap.css" rel="stylesheet">
    <style>.content {padding-top: 80px;}</style>
  </head>

  <body>

    <div class="topbar">
      <div class="fill">
        <div class="container">
          <h1><a href="/" class="brand">My Tumblelog</a>! <small>Starring MongoDB and Django-MongoDB
        </div>
      </div>
    </div>

    <div class="container">
      <div class="content">
        {% block page_header %}{% endblock %}
        {% block content %}{% endblock %}
      </div>
    </div>

  </body>
</html>
```

Create the frontpage for the blog, which should list all the posts. Add the following template to the `templates/tumblelog/post_list.html`:

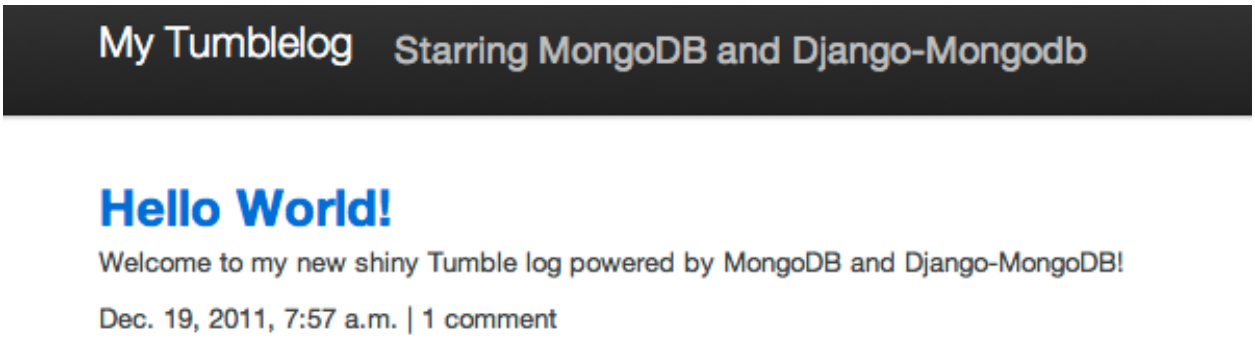
```
{% extends "base.html" %}

{% block content %}
    {% for post in posts_list %}
      <h2><a href="{% url post slug=post.slug %}">{{ post.title }}</a></h2>
      <p>{{ post.body|truncatewords:20 }}</p>
      <p>
        {{ post.created_at }} |
        {% with total=post.comments|length %}
            {{ total }} comment{{ total|pluralize }}
        {% endwith %}
      </p>
    {% endfor %}
{% endblock %}
```

Finally, add `templates/tumblelog/post_detail.html` for the individual posts:

```
{% extends "base.html" %}

{% block page_header %}
  <div class="page-header">
    <h1>{{ post.title }}</h1>
  </div>
{% endblock %}

{% block content %}
  <p>{{ post.body }}<p>
  <p>{{ post.created_at }}</p>
  <hr>
  <h2>Comments</h2>
```

```
  {% if post.comments %}
    {% for comment in post.comments %}
       <p>{{ comment.body }}</p>
       <p><strong>{{ comment.author }}</strong> <small>on {{ comment.created_at }}</small></p>
      {{ comment.text }}
    {% endfor %}
  {% endif %}
{% endblock %}
```

Run `python manage.py runserver` to see your new tumblelog! Go to http://localhost:8000/ and you should see:



45.1.4 Add Comments to the Blog

In the next step you will provide the facility for readers of the tumblelog to comment on posts. This a requires custom form and view to handle the form, and data. You will also update the template to include the form.

Create the Comments Form

You must customize form handling to deal with embedded comments. By extending `ModelForm`, it is possible to append the comment to the post on save. Create and add the following to `forms.py`:

```
from django.forms import ModelForm
from tumblelog.models import Comment


class CommentForm(ModelForm):

    def __init__(self, object, *args, **kwargs):
        """Override the default to store the original document
        that comments are embedded in.
        """
        self.object = object
        return super(CommentForm, self).__init__(*args, **kwargs)

    def save(self, *args):
        """Append to the comments list and save the post"""
        self.object.comments.append(self.instance)
        self.object.save()
        return self.object
```

```
    class Meta:
        model = Comment
```

Handle Comments in the View

You must extend the generic views need to handle the form logic. Add the following to the `views.py` file:

```
from django.http import HttpResponseRedirect
from django.views.generic import DetailView
from tumblelog.forms import CommentForm


class PostDetailView(DetailView):
    methods = ['get', 'post']

    def get(self, request, *args, **kwargs):
        self.object = self.get_object()
        form = CommentForm(object=self.object)
        context = self.get_context_data(object=self.object, form=form)
        return self.render_to_response(context)

    def post(self, request, *args, **kwargs):
        self.object = self.get_object()
        form = CommentForm(object=self.object, data=request.POST)

        if form.is_valid():
            form.save()
            return HttpResponseRedirect(self.object.get_absolute_url())

        context = self.get_context_data(object=self.object, form=form)
        return self.render_to_response(context)
```

Note: The `PostDetailView` class extends the `DetailView` class so that it can handle `GET` and `POST` requests. On `POST`, `post()` validates the comment: if valid, `post()` appends the comment to the post.

Don't forget to update the `urls.py` file and import the `PostDetailView` class to replace the `DetailView` class.

Add Comments to the Templates

Finally, you can add the form to the templates, so that readers can create comments. Splitting the template for the forms out into `templates/_forms.html` will allow maximum reuse of forms code:

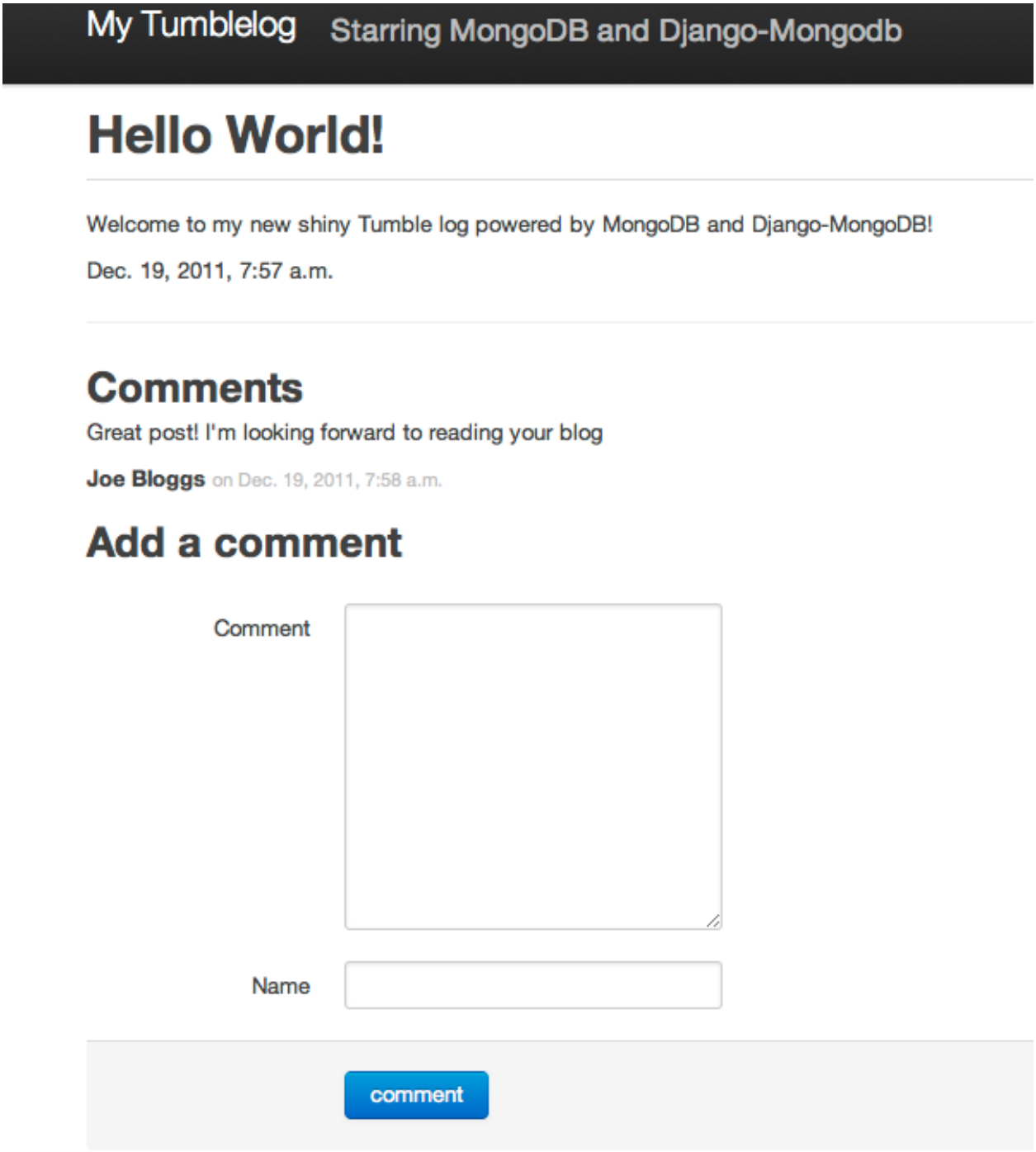
```
<fieldset>
{% for field in form.visible_fields %}
<div class="clearfix {% if field.errors %}error{% endif %}">
  {{ field.label_tag }}
  <div class="input">
    {{ field }}
    {% if field.errors or field.help_text %}
      <span class="help-inline">
      {% if field.errors %}
        {{ field.errors|join:' ' }}
      {% else %}
        {{ field.help_text }}
      {% endif %}
```

```
      </span>
    {% endif %}
  </div>
</div>
{% endfor %}
{% csrf_token %}
<div style="display:none">{% for h in form.hidden_fields %} {{ h }}{% endfor %}</div>
</fieldset>
```

After the comments section in `post_detail.html` add the following code to generate the comments form:

```
<h2>Add a comment</h2>
<form action="." method="post">
  {% include "_forms.html" %}
  <div class="actions">
    <input type="submit" class="btn primary" value="comment">
  </div>
</form>
```

Your tumblelog's readers can now comment on your posts! Run `python manage.py runserver` to see the changes by visiting http://localhost:8000/hello-world/. You should see the following:



45.1.5 Add Site Administration Interface

While you may always add posts using the shell interface as above, you can easily create an administrative interface for posts with Django. Enable the admin by adding the following apps to `INSTALLED_APPS` in `settings.py`.

- `django.contrib.admin`
- `django_mongodb_engine`
- `djangotoolbox`

- tumblelog

Warning: This application does not require the Sites framework. As a result, remove django.contrib.sites from INSTALLED_APPS. If you need it later please read SITE_ID issues document.

Create a admin.py file and register the Post model with the admin app:

```
from django.contrib import admin
from tumblelog.models import Post

admin.site.register(Post)
```

Note: The above modifications deviate from the default django-nonrel and djangotoolbox mode of operation. Django's administration module will not work unless you exclude the comments field. By making the comments field non-editable in the "admin" model definition, you will allow the administrative interface to function.

If you need an administrative interface for a ListField you must write your own Form / Widget.

See Also:

The Django Admin documentation docs for additional information.

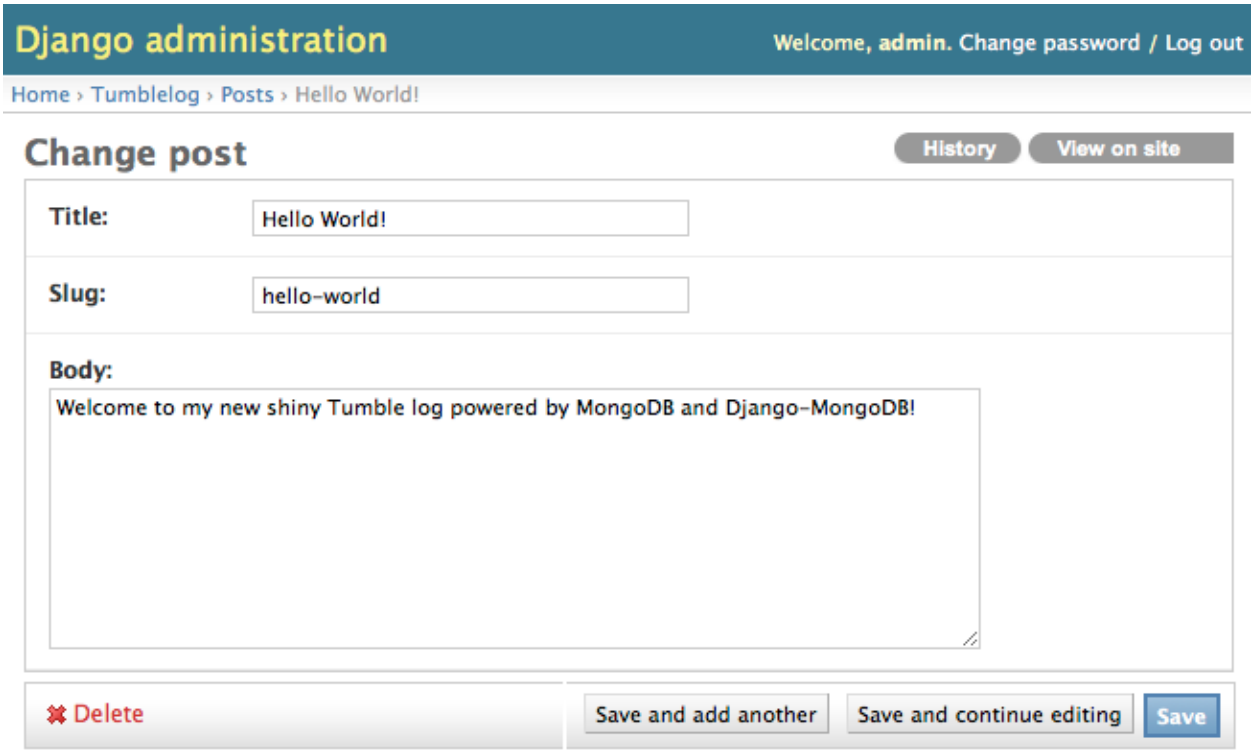
Update the urls.py to enable the administrative interface. Add the import and discovery mechanism to the top of the file and then add the admin import rule to the urlpatterns:

```
# Enable admin
from django.contrib import admin
admin.autodiscover()

urlpatterns = patterns('',

    # ...

    url(r'^admin/', include(admin.site.urls)),
)
```

Finally, add a superuser and setup the indexes by issuing the following command at the system prompt:

```
python manage.py syncdb
```

Once done run the server and you can login to admin by going to http://localhost:8000/admin/.



45.1.6 Convert the Blog to a Tumblelog

Currently, the application only supports posts. In this section you will add special post types including: *Video*, *Image* and *Quote* to provide a more traditional tumblelog application. Adding this data requires no migration.

In `models.py` update the `Post` class to add new fields for the new post types. Mark these fields with `blank=True` so that the fields can be empty.

Update `Post` in the `models.py` files to resemble the following:

```
POST_CHOICES = (
    ('p', 'post'),
    ('v', 'video'),
    ('i', 'image'),
    ('q', 'quote'),
)


class Post(models.Model):
    created_at = models.DateTimeField(auto_now_add=True)
    title = models.CharField(max_length=255)
    slug = models.SlugField()

    comments = ListField(EmbeddedModelField('Comment'), editable=False)

    post_type = models.CharField(max_length=1, choices=POST_CHOICES, default='p')

    body = models.TextField(blank=True, help_text="The body of the Post / Quote")
    embed_code = models.TextField(blank=True, help_text="The embed code for video")
    image_url = models.URLField(blank=True, help_text="Image src")
    author = models.CharField(blank=True, max_length=255, help_text="Author name")
```

```
    def get_absolute_url(self):
        return reverse('post', kwargs={"slug": self.slug})

    def __unicode__(self):
        return self.title
```

Note: Django-Nonrel doesn't support multi-table inheritance. This means that you will have to manually create an administrative form to handle data validation for the different post types.

The "Abstract Inheritance" facility means that the view logic would need to merge data from multiple collections.

The administrative interface should now handle adding multiple types of post. To conclude this process, you must update the frontend display to handle and output the different post types.

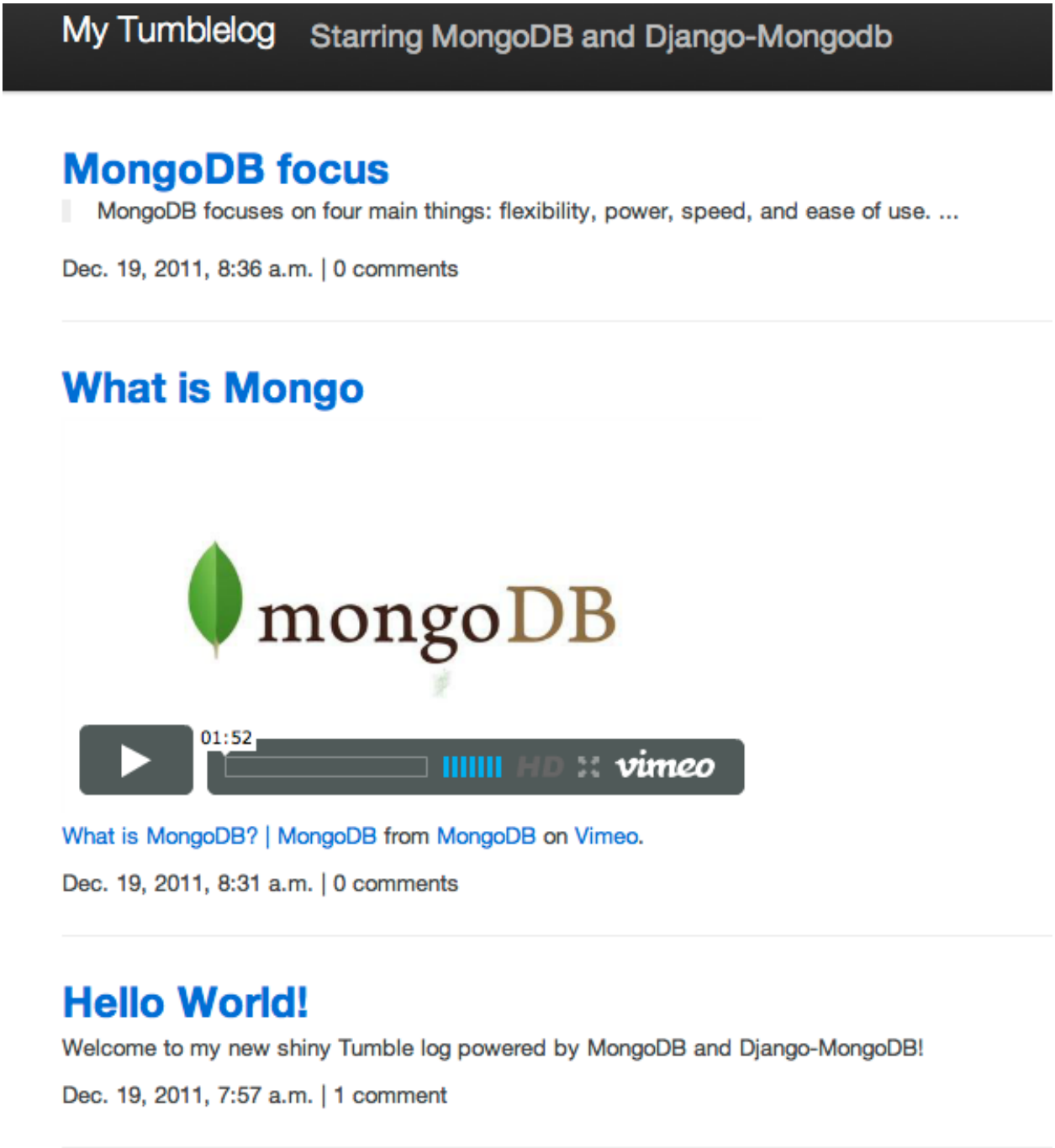
In the `post_list.html` file, change the post output display to resemble the following:

```
{% if post.post_type == 'p' %}
  <p>{{ post.body|truncatewords:20 }}</p>
{% endif %}
{% if post.post_type == 'v' %}
  {{ post.embed_code|safe }}
{% endif %}
{% if post.post_type == 'i' %}
  <p><img src="{{ post.image_url }}" /><p>
{% endif %}
{% if post.post_type == 'q' %}
  <blockquote>{{ post.body|truncatewords:20 }}</blockquote>
  <p>{{ post.author }}</p>
{% endif %}
```

In the `post_detail.html` file, change the output for full posts:

```
{% if post.post_type == 'p' %}
  <p>{{ post.body }}<p>
{% endif %}
{% if post.post_type == 'v' %}
  {{ post.embed_code|safe }}
{% endif %}
{% if post.post_type == 'i' %}
  <p><img src="{{ post.image_url }}" /><p>
{% endif %}
{% if post.post_type == 'q' %}
  <blockquote>{{ post.body }}</blockquote>
  <p>{{ post.author }}</p>
{% endif %}
```

Now you have a fully fledged tumbleblog using Django and MongoDB!



45.2 Write a Tumblelog Application with Flask and MongoEngine

45.2.1 Introduction

This tutorial describes the process for creating a basic tumblelog application using the popular Flask Python web-framework in conjunction with the *MongoDB* database.

The tumblelog will consist of two parts:

1. A public site that lets people view posts and comment on them.
2. An admin site that lets you add and change posts.

This tutorial assumes that you are already familiar with Flask and have a basic familiarity with MongoDB and have *installed MongoDB* (page 3). This tutorial uses MongoEngine as the Object Document Mapper (ODM,) this component may simplify the interaction between Flask and MongoDB.

Where to get help

If you're having trouble going through this tutorial, please post a message to mongodb-user or join the IRC chat in *#mongodb* on irc.freenode.net to chat with other MongoDB users who might be able to help.

45.2.2 Installation

Begin by installing packages required by later steps in this tutorial.

Prerequisite

This tutorial uses pip to install packages and virtualenv to isolate Python environments. While these tools and this configuration are not required as such, they ensure a standard environment and are strongly recommended. Issue the following command at the system prompt:

```
pip install virtualenv
virtualenv myproject
```

Respectively, these commands: install the `virtualenv` program (using `pip`) and create a isolated python environment for this project (named `myproject`.)

To activate `myproject` environment at the system prompt, use the following command:

```
source myproject/bin/activate
```

Install Packages

Flask is a "microframework," because it provides a small core of functionality and is highly extensible. For the "tumblelog" project, this tutorial includes task and the following extension:

- WTForms provides easy form handling.
- Flask-MongoEngine provides integration between MongoEngine, Flask, and WTForms.
- Flask-Script for an easy to use development server

Install with the following commands:

```
pip install flask
pip install flask-script
pip install WTForms
pip install mongoengine
pip install flask_mongoengine
```

Continue with the tutorial to begin building the "tumblelog" application.

45.2.3 Build a Blog to Get Started

First, create a simple "bare bones" application. Make a directory named `tumblelog` for the project and then, add the following content into a file named `__init__.py`:

```
from flask import Flask
app = Flask(__name__)


if __name__ == '__main__':
    app.run()
```

Next, create the `manage.py` file. [1] Use this file to load additional Flask-scripts in the future. Flask-scripts provides a development server and shell:

```
# Set the path
import os, sys
sys.path.append(os.path.abspath(os.path.join(os.path.dirname(__file__), '..')))

from flask.ext.script import Manager, Server
from tumblelog import app

manager = Manager(app)

# Turn on debugger by default and reloader
manager.add_command("runserver", Server(
    use_debugger = True,
    use_reloader = True,
    host = '0.0.0.0')
)

if __name__ == "__main__":
    manager.run()
```

You can run this application with a test server, by issuing the following command at the system prompt:

```
python manage.py runserver
```

There should be no errors, and you can visit http://localhost:5000/ in a web browser to view a page with a "404" message.

Configure MongoEngine and Flask

Install the Flask extension and add the configuration. Update `tumblelog/__init__.py` so that it resembles the following:

```
from flask import Flask
from flask.ext.mongoengine import MongoEngine

app = Flask(__name__)
app.config["MONGODB_SETTINGS"] = {'DB': "my_tumble_log"}
app.config["SECRET_KEY"] = "KeepThisS3cr3t"

db = MongoEngine(app)

if __name__ == '__main__':
    app.run()
```

[1] This concept will be familiar to users of Django.

See Also:

The MongoEngine Settings documentation for additional configuration options.

Define the Schema

The first step in writing a tumblelog in Flask is to define the "models" or in MongoDB's terminology *documents*.

In this application, you will define posts and comments, so that each `Post` can contain a list of `Comments`. Edit the `models.py` file so that it resembles the following:

```
import datetime
from flask import url_for
from tumblelog import db


class Post(db.Document):
    created_at = db.DateTimeField(default=datetime.datetime.now, required=True)
    title = db.StringField(max_length=255, required=True)
    slug = db.StringField(max_length=255, required=True)
    body = db.StringField(required=True)
    comments = db.ListField(db.EmbeddedDocumentField('Comment'))

    def get_absolute_url(self):
        return url_for('post', kwargs={"slug": self.slug})

    def __unicode__(self):
        return self.title

    meta = {
        'allow_inheritance': True,
        'indexes': ['-created_at', 'slug'],
        'ordering': ['-created_at']
    }


class Comment(db.EmbeddedDocument):
    created_at = db.DateTimeField(default=datetime.datetime.now, required=True)
    body = db.StringField(verbose_name="Comment", required=True)
    author = db.StringField(verbose_name="Name", max_length=255, required=True)
```

As above, MongoEngine syntax is simple and declarative. If you have a Django background, the syntax may look familiar. This example defines indexes for `Post`: one for the `created_at` date as our frontpage will order by date and another for the individual post `slug`.

Add Data with the Shell

The `manage.py` provides a shell interface for the application that you can use to insert data into the tumblelog. Before configuring the "urls" and "views" for this application, you can use this interface to interact with your the tumblelog. Begin by issuing the following command to load the Python shell:

```
python manage.py shell
```

Create the first post using the following sequence of operations:

```
>>> from tumblelog.models import *
>>> post = Post(
```

```
... title="Hello World!",
... slug="hello-world",
... body="Welcome to my new shiny Tumble log powered by MongoDB, MongoEngine, and Flask"
... )
>>> post.save()
```

Add comments using the following sequence of operations:

```
>>> post.comments
[]
>>> comment = Comment(
... author="Joe Bloggs",
... body="Great post! I'm looking forward to reading your blog!"
... )
>>> post.comments.append(comment)
>>> post.save()
```

Finally, inspect the post:

```
>>> post = Post.objects.get()
>>> post
<Post: Hello World!>
>>> post.comments
[<Comment: Comment object>]
```

Add the Views

Using Flask's class-based views system allows you to produce `List` and `Detail` views for tumblelog posts. Add `views.py` and create a *posts* blueprint:

```
from flask import Blueprint, request, redirect, render_template, url_for
from flask.views import MethodView
from tumblelog.models import Post, Comment

posts = Blueprint('posts', __name__, template_folder='templates')


class ListView(MethodView):

    def get(self):
        posts = Post.objects.all()
        return render_template('posts/list.html', posts=posts)


class DetailView(MethodView):

    def get(self, slug):
        post = Post.objects.get_or_404(slug=slug)
        return render_template('posts/detail.html', post=post)


# Register the urls
posts.add_url_rule('/', view_func=ListView.as_view('list'))
posts.add_url_rule('/<slug>/', view_func=DetailView.as_view('detail'))
```

Now in `__init__.py` register the blueprint, avoiding a circular dependency by registering the blueprints in a method. Add the following code to the module:

```
def register_blueprints(app):
    # Prevents circular imports
    from tumblelog.views import posts
    app.register_blueprint(posts)

register_blueprints(app)
```

Add this method and method call to the main body of the module and not in the main block.

Add Templates

In the `tumblelog` directory add the `templates` and `templates/posts` directories to store the tumblelog templates:

```
mkdir -p templates/posts
```

Create a base template. All other templates will inherit from this template, which should exist in the `templates/base.html` file:

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <title>My Tumblelog</title>
    <link href="http://twitter.github.com/bootstrap/1.4.0/bootstrap.css" rel="stylesheet">
    <style>.content {padding-top: 80px;}</style>
  </head>

  <body>

    {%- block topbar -%}
    <div class="topbar">
      <div class="fill">
        <div class="container">
          <h2>
              <a href="/" class="brand">My Tumblelog</a> <small>Starring Flask, MongoDB and MongoEngi
          </h2>
        </div>
      </div>
    </div>
    {%- endblock -%}

    <div class="container">
      <div class="content">
        {% block page_header %}{% endblock %}
        {% block content %}{% endblock %}
      </div>
    </div>
    {% block js_footer %}{% endblock %}
  </body>
</html>
```

Continue by creating a landing page for the blog that will list all posts. Add the following to the `templates/posts/list.html` file:

```
{% extends "base.html" %}

{% block content %}
```

```
    {% for post in posts %}
      <h2><a href="{{ url_for('posts.detail', slug=post.slug) }}">{{ post.title }}</a></h2>
      <p>{{ post.body|truncate(100) }}</p>
      <p>
        {{ post.created_at.strftime('%H:%M %Y-%m-%d') }} |
        {% with total=post.comments|length %}
            {{ total }} comment {%- if total > 1 %}s{%- endif -%}
        {% endwith %}
      </p>
    {% endfor %}
{% endblock %}
```

Finally, add `templates/posts/detail.html` template for the individual posts:

```
{% extends "base.html" %}

{% block page_header %}
  <div class="page-header">
    <h1>{{ post.title }}</h1>
  </div>
{% endblock %}

{% block content %}
  <p>{{ post.body }}<p>
  <p>{{ post.created_at.strftime('%H:%M %Y-%m-%d') }}</p>
  <hr>
  <h2>Comments</h2>
  {% if post.comments %}
    {% for comment in post.comments %}
       <p>{{ comment.body }}</p>
       <p><strong>{{ comment.author }}</strong> <small>on {{ comment.created_at.strftime('%H:%M %Y-%m
      {{ comment.text }}
    {% endfor %}
  {% endif %}
{% endblock %}
```

At this point, you can run the `python manage.py runserver` command again to see your new tumblelog! Go to http://localhost:5000 to see something that resembles the following:

45.2.4 Add Comments to the Blog

In the next step you will provide the facility for readers of the tumblelog to comment on posts. To provide commenting, you will create a form using WTForms that will update the view to handle the form data and update the template to include the form.

Handle Comments in the View

Begin by updating and refactoring the `views.py` file so that it can handle the form. Begin by adding the `import` statement and the `DetailView` class to this file:

```
from flask.ext.mongoengine.wtf import model_form

...

class DetailView(MethodView):

    form = model_form(Comment, exclude=['created_at'])

    def get_context(self, slug):
        post = Post.objects.get_or_404(slug=slug)
        form = self.form(request.form)

        context = {
            "post": post,
            "form": form
        }
        return context

    def get(self, slug):
        context = self.get_context(slug)
        return render_template('posts/detail.html', **context)

    def post(self, slug):
        context = self.get_context(slug)
        form = context.get('form')

        if form.validate():
            comment = Comment()
            form.populate_obj(comment)

            post = context.get('post')
            post.comments.append(comment)
            post.save()

            return redirect(url_for('posts.detail', slug=slug))

        return render_template('posts/detail.html', **context)
```

Note: `DetailView` extends the default Flask `MethodView`. This code remains DRY by defining a *get_context* method to get the default context for both `GET` and `POST` requests. On `POST`, `post()` validates the comment: if valid, `post()` appends the comment to the post.

Add Comments to the Templates

Finally, you can add the form to the templates, so that readers can create comments. Create a macro for the forms in `templates/_forms.html` will allow you to reuse the form code:

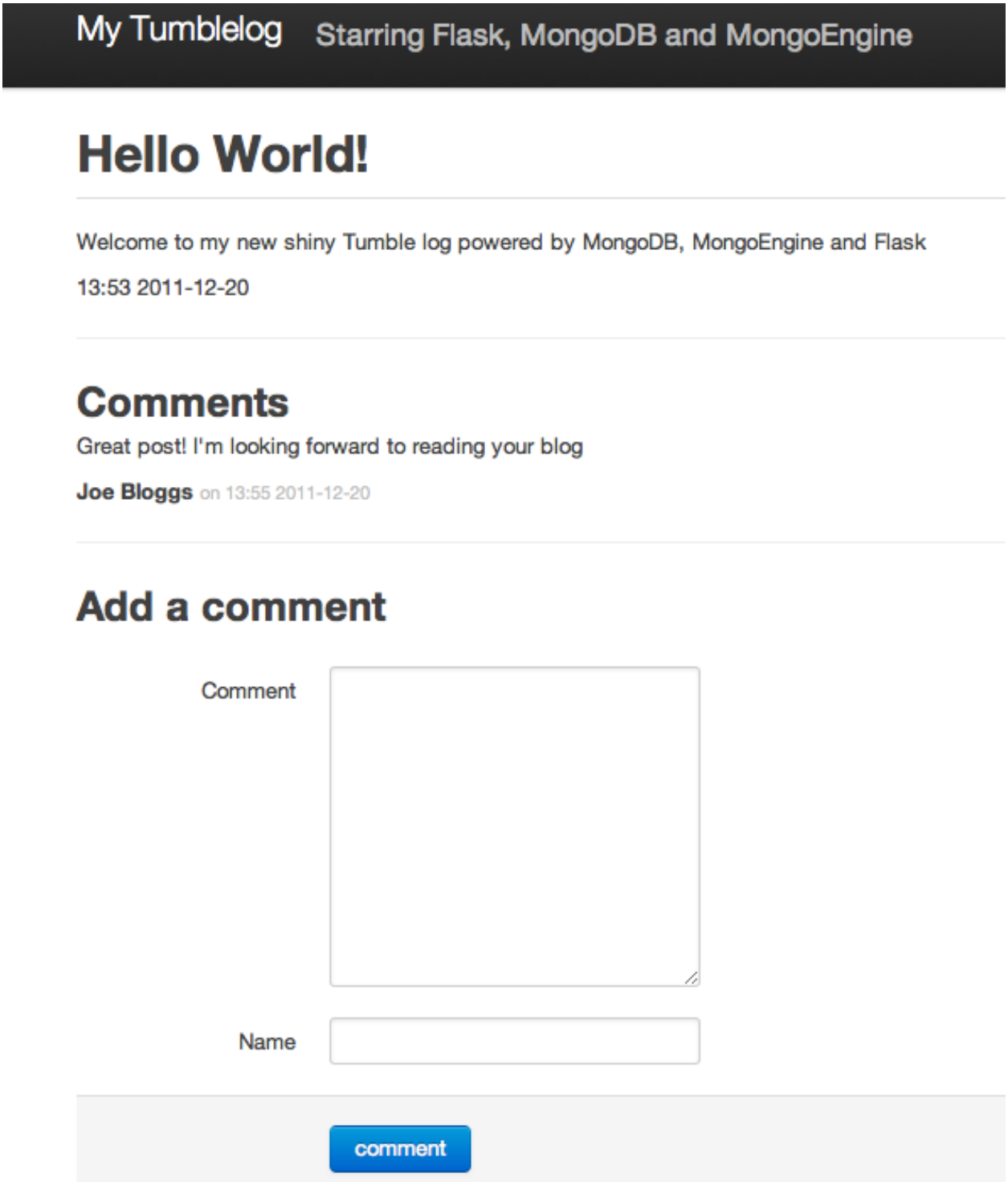
```
{% macro render(form) -%}
<fieldset>
{% for field in form %}
{% if field.type in ['CSRFTokenField', 'HiddenField'] %}
```

```
  {{ field() }}
{% else %}
  <div class="clearfix {% if field.errors %}error{% endif %}">
    {{ field.label }}
    <div class="input">
      {% if field.name == "body" %}
        {{ field(rows=10, cols=40) }}
      {% else %}
        {{ field() }}
      {% endif %}
      {% if field.errors or field.help_text %}
        <span class="help-inline">
        {% if field.errors %}
          {{ field.errors|join(' ') }}
        {% else %}
          {{ field.help_text }}
        {% endif %}
        </span>
      {% endif %}
    </div>
  </div>
{% endif %}
{% endfor %}
</fieldset>
{% endmacro %}
```

Add the comments form to `templates/posts/detail.html`. Insert an `import` statement at the top of the page and then output the form after displaying comments:

```
{% import "_forms.html" as forms %}

...

<hr>
<h2>Add a comment</h2>
<form action="." method="post">
  {{ forms.render(form) }}
  <div class="actions">
    <input type="submit" class="btn primary" value="comment">
  </div>
</form>
```

Your tumblelog's readers can now comment on your posts! Run `python manage.py runserver` to see the changes.



45.2.5 Add a Site Administration Interface

While you may always add posts using the shell interface as above, in this step you will add an administrative interface for the tumblelog site. To add the administrative interface you will add authentication and an additional view. This tutorial only addresses adding and editing posts: a "delete" view and detection of slug collisions are beyond the scope of this tutorial.

Add Basic Authentication

For the purposes of this tutorial all we need is a very basic form of authentication. The following example borrows from the an example Flask "Auth snippet". Create the file `auth.py` with the following content:

```
from functools import wraps
from flask import request, Response


def check_auth(username, password):
    """This function is called to check if a username /
    password combination is valid.
    """
    return username == 'admin' and password == 'secret'


def authenticate():
    """Sends a 401 response that enables basic auth"""
    return Response(
    'Could not verify your access level for that URL.\n'
    'You have to login with proper credentials', 401,
    {'WWW-Authenticate': 'Basic realm="Login Required"'})


def requires_auth(f):
    @wraps(f)
    def decorated(*args, **kwargs):
        auth = request.authorization
        if not auth or not check_auth(auth.username, auth.password):
            return authenticate()
        return f(*args, **kwargs)
    return decorated
```

Note: This creates a *requires_auth* decorator: provides basic authentication. Decorate any view that needs authentication with this decorator. The username is `admin` and password is `secret`.

Write an Administrative View

Create the views and admin blueprint in `admin.py`. The following view is deliberately generic, to facilitate customization.

```
from flask import Blueprint, request, redirect, render_template, url_for
from flask.views import MethodView

from flask.ext.mongoengine.wtf import model_form

from tumblelog.auth import requires_auth
from tumblelog.models import Post, Comment

admin = Blueprint('admin', __name__, template_folder='templates')


class List(MethodView):
    decorators = [requires_auth]
    cls = Post
```

```
    def get(self):
        posts = self.cls.objects.all()
        return render_template('admin/list.html', posts=posts)


class Detail(MethodView):

    decorators = [requires_auth]

    def get_context(self, slug=None):
        form_cls = model_form(Post, exclude=('created_at', 'comments'))

        if slug:
            post = Post.objects.get_or_404(slug=slug)
            if request.method == 'POST':
                form = form_cls(request.form, inital=post._data)
            else:
                form = form_cls(obj=post)
        else:
            post = Post()
            form = form_cls(request.form)

        context = {
            "post": post,
            "form": form,
            "create": slug is None
        }
        return context

    def get(self, slug):
        context = self.get_context(slug)
        return render_template('admin/detail.html', **context)

    def post(self, slug):
        context = self.get_context(slug)
        form = context.get('form')

        if form.validate():
            post = context.get('post')
            form.populate_obj(post)
            post.save()

            return redirect(url_for('admin.index'))
        return render_template('admin/detail.html', **context)


# Register the urls
admin.add_url_rule('/admin/', view_func=List.as_view('index'))
admin.add_url_rule('/admin/create/', defaults={'slug': None}, view_func=Detail.as_view('create'))
admin.add_url_rule('/admin/<slug>/', view_func=Detail.as_view('edit'))
```

Note: Here, the `List` and `Detail` views are similar to the frontend of the site; however, `requires_auth` decorates both views.

The "Detail" view is slightly more complex: to set the context, this view checks for a slug and if there is no slug, `Detail` uses the view for creating a new post. If a slug exists, `Detail` uses the view for editing an existing post.

In the `__init__.py` file update the `register_blueprints()` method to import the new admin blueprint.

```
def register_blueprints(app):
    # Prevents circular imports
    from tumblelog.views import posts
    from tumblelog.admin import admin
    app.register_blueprint(posts)
    app.register_blueprint(admin)
```

Create Administrative Templates

Similar to the user-facing portion of the site, the administrative section of the application requires three templates: a base template a list view, and a detail view.

Create an `admin` directory for the templates. Add a simple main index page for the admin in the `templates/admin/base.html` file:

```
{% extends "base.html" %}

{%- block topbar -%}
<div class="topbar" data-dropdown="dropdown">
  <div class="fill">
    <div class="container">
      <h2>
           <a href="{{ url_for('admin.index') }}" class="brand">My Tumblelog Admin</a>
      </h2>
      <ul class="nav secondary-nav">
        <li class="menu">
           <a href="{{ url_for("admin.create") }}" class="btn primary">Create new post</a>
        </li>
      </ul>
    </div>
  </div>
</div>
{%- endblock -%}
```

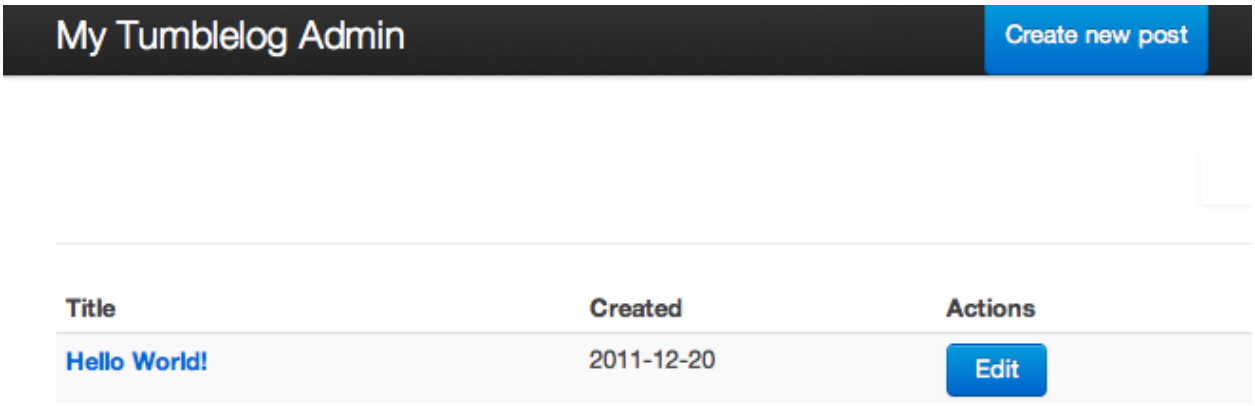
List all the posts in the `templates/admin/list.html` file:

```
{% extends "admin/base.html" %}

{% block content %}
  <table  class="condensed-table zebra-striped">
    <thead>
      <th>Title</th>
      <th>Created</th>
      <th>Actions</th>
    </thead>
    <tbody>
    {% for post in posts %}
      <tr>
        <th><a href="{{ url_for('admin.edit', slug=post.slug) }}">{{ post.title }}</a></th>
        <td>{{ post.created_at.strftime('%Y-%m-%d') }}</td>
        <td><a href="{{ url_for("admin.edit", slug=post.slug) }}" class="btn primary">Edit</a></td>
      </tr>
    {% endfor %}
    </tbody>
  </table>
{% endblock %}
```

Add a temple to create and edit posts in the `templates/admin/detail.html` file:

```
{% extends "admin/base.html" %}
{% import "_forms.html" as forms %}

{% block content %}
  <h2>
    {% if create %}
      Add new Post
    {% else %}
      Edit Post
    {% endif %}
  </h2>

  <form action="?{{ request.query_string }}" method="post">
    {{ forms.render(form) }}
    <div class="actions">
      <input type="submit" class="btn primary" value="save">
      <a href="{{ url_for("admin.index") }}" class="btn secondary">Cancel</a>
    </div>
  </form>
{% endblock %}
```

The administrative interface is ready for use. Restart the test server (i.e. `runserver`) so that you can log in to the administrative interface located at http://localhost:5000/admin/. (The username is `admin` and the password is `secret`.)



45.2.6 Converting the Blog to a Tumblelog

Currently, the application only supports posts. In this section you will add special post types including: *Video*, *Image* and *Quote* to provide a more traditional tumblelog application. Adding this data requires no migration because MongoEngine supports document inheritance.

Begin by refactoring the `Post` class to operate as a base class and create new classes for the new post types. Update the `models.py` file to include the code to replace the old `Post` class:

```
class Post(db.DynamicDocument):
    created_at = db.DateTimeField(default=datetime.datetime.now, required=True)
    title = db.StringField(max_length=255, required=True)
    slug = db.StringField(max_length=255, required=True)
    comments = db.ListField(db.EmbeddedDocumentField('Comment'))
```

```
    def get_absolute_url(self):
        return url_for('post', kwargs={"slug": self.slug})

    def __unicode__(self):
        return self.title

    @property
    def post_type(self):
        return self.__class__.__name__

    meta = {
        'allow_inheritance': True,
        'indexes': ['-created_at', 'slug'],
        'ordering': ['-created_at']
    }


class BlogPost(Post):
    body = db.StringField(required=True)


class Video(Post):
    embed_code = db.StringField(required=True)


class Image(Post):
    image_url = db.StringField(required=True, max_length=255)


class Quote(Post):
    body = db.StringField(required=True)
    author = db.StringField(verbose_name="Author Name", required=True, max_length=255)
```

Note: In the `Post` class the `post_type` helper returns the class name, which will make it possible to render the various different post types in the templates.

As MongoEngine handles returning the correct classes when fetching `Post` objects you do not need to modify the interface view logic: only modify the templates.

Update the `templates/posts/list.html` file and change the post output format as follows:

```
{% if post.body %}
  {% if post.post_type == 'Quote' %}
    <blockquote>{{ post.body|truncate(100) }}</blockquote>
    <p>{{ post.author }}</p>
  {% else %}
    <p>{{ post.body|truncate(100) }}</p>
  {% endif %}
{% endif %}
{% if post.embed_code %}
  {{ post.embed_code|safe() }}
{% endif %}
{% if post.image_url %}
  <p><img src="{{ post.image_url }}" /><p>
{% endif %}
```

In the `templates/posts/detail.html` change the output for full posts as follows:

```
{% if post.body %}
  {% if post.post_type == 'Quote' %}
    <blockquote>{{ post.body }}</blockquote>
    <p>{{ post.author }}</p>
  {% else %}
    <p>{{ post.body }}</p>
  {% endif %}
{% endif %}
{% if post.embed_code %}
  {{ post.embed_code|safe() }}
{% endif %}
{% if post.image_url %}
  <p><img src="{{ post.image_url }}" /><p>
{% endif %}
```

Updating the Administration

In this section you will update the administrative interface to support the new post types.

Begin by, updating the `admin.py` file to import the new document models and then update `get_context()` in the `Detail` class to dynamically create the correct model form to use:

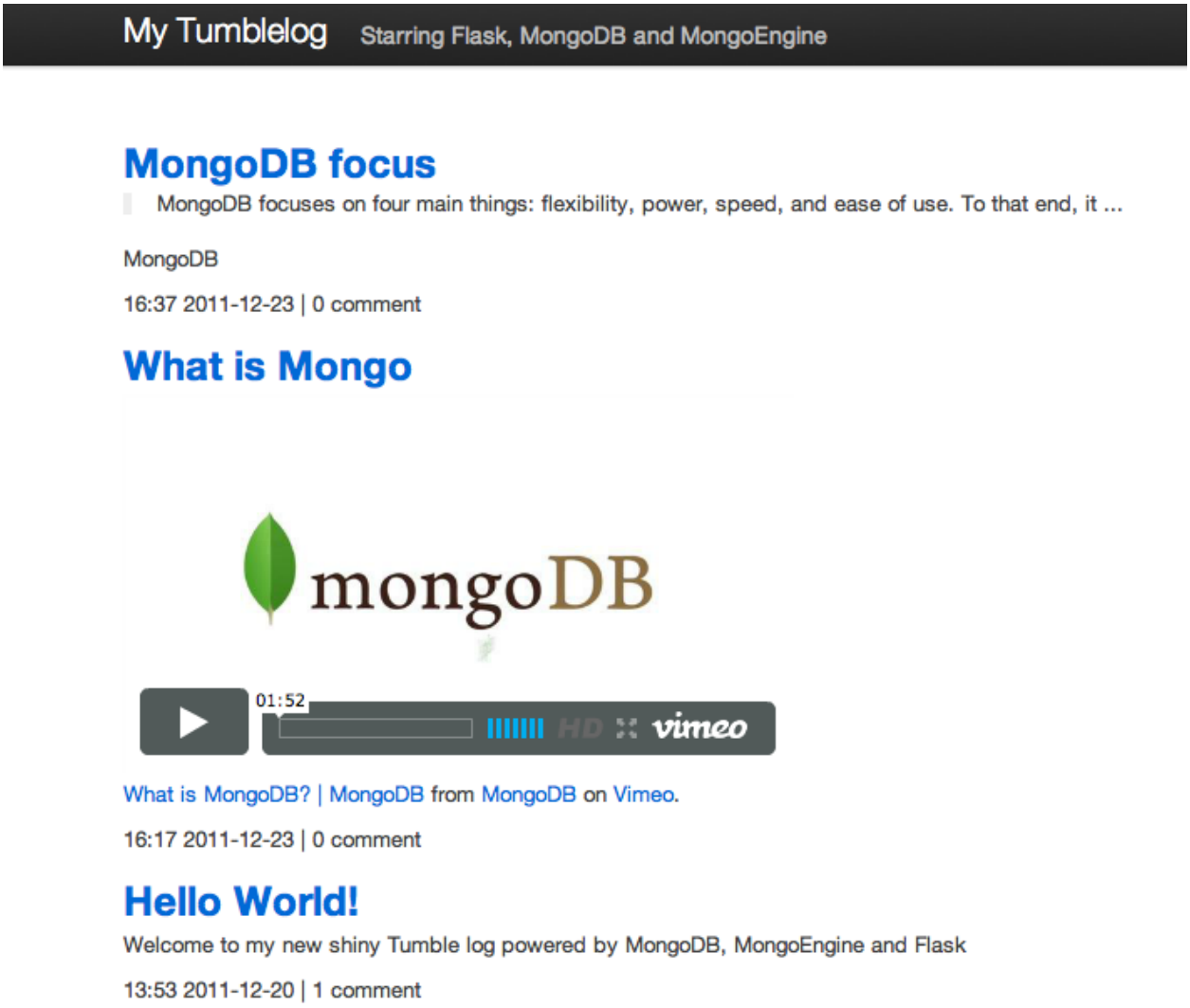
```
from tumblelog.models import Post, BlogPost, Video, Image, Quote, Comment

# ...

class Detail(MethodView):

    decorators = [requires_auth]
    # Map post types to models
    class_map = {
        'post': BlogPost,
        'video': Video,
        'image': Image,
        'quote': Quote,
    }

    def get_context(self, slug=None):

        if slug:
            post = Post.objects.get_or_404(slug=slug)
            # Handle old posts types as well
            cls = post.__class__ if post.__class__ != Post else BlogPost
            form_cls = model_form(cls,  exclude=('created_at', 'comments'))
            if request.method == 'POST':
                form = form_cls(request.form, inital=post._data)
            else:
                form = form_cls(obj=post)
        else:
            # Determine which post type we need
            cls = self.class_map.get(request.args.get('type', 'post'))
            post = cls()
            form_cls = model_form(cls,  exclude=('created_at', 'comments'))
            form = form_cls(request.form)
        context = {
            "post": post,
            "form": form,
```

```
            "create": slug is None
        }
        return context

    # ...
```

Update the `template/admin/base.html` file to create a new post drop down menu in the toolbar:

```
{% extends "base.html" %}

{%- block topbar -%}
<div class="topbar" data-dropdown="dropdown">
  <div class="fill">
    <div class="container">
      <h2>
           <a href="{{ url_for('admin.index') }}" class="brand">My Tumblelog Admin</a>
      </h2>
      <ul class="nav secondary-nav">
        <li class="menu">
          <a href="#" class="menu">Create new</a>
          <ul class="menu-dropdown">
            {% for type in ('post', 'video', 'image', 'quote') %}
                <li><a href="{{ url_for("admin.create", type=type) }}">{{ type|title }}</a></li>
            {% endfor %}
          </ul>
        </li>
      </ul>
    </div>
  </div>
</div>
{%- endblock -%}

{% block js_footer %}
  <script src="http://ajax.googleapis.com/ajax/libs/jquery/1.7.1/jquery.min.js"></script>
  <script src="http://twitter.github.com/bootstrap/1.4.0/bootstrap-dropdown.js"></script>
{% endblock %}
```

Now you have a fully fledged tumbleblog using Flask and MongoEngine!



45.2.7 Additional Resources

The complete source code is available on Github: <https://github.com/rozza/flask-tumblelog>

Part XII

MongoDB Tutorials

This index page provides a complete listing of all tutorials available as part of the *MongoDB Manual* (page 1). In addition to these documents, you can refer to the introductory *MongoDB Tutorial* (page 20). If there is a process or pattern that you would like to see included here, please open a Jira Case.

CHAPTER 46

Getting Started

- *Install MongoDB on Linux* (page 12)
- *Install MongoDB on Red Hat Enterprise, CentOS, or Fedora Linux* (page 3)
- *Install MongoDB on Debian* (page 9)
- *Install MongoDB on Ubuntu* (page 6)
- *Install MongoDB on OS X* (page 13)
- *Install MongoDB on Windows* (page 16)
- *Getting Started with MongoDB Development* (page 20)

CHAPTER 47

Administration

47.1 Use Database Commands

The MongoDB command interface provides access to all *non CRUD* database operations. Fetching server stats, initializing a replica set, and running a map-reduce job are all accomplished with commands.

See *Database Commands Quick Reference* (page 885) for list of all commands sorted by function, and *Database Commands* (page 739) for a list of all commands sorted alphabetically.

47.1.1 Database Command Form

You specify a command first by constructing a standard *BSON* document whose first key is the name of the command. For example, specify the `isMaster` (page 772) command using the following *BSON* document:

```
{ isMaster: 1 }
```

47.1.2 Issue Commands

The `mongo` (page 908) shell provides a helper method for running commands called `db.runCommand()` (page 853). The following operation in `mongo` (page 908) runs the above command:

```
db.runCommand( { isMaster: 1 } )
```

Many *drivers* (page 435) provide an equivalent for the `db.runCommand()` (page 853) method. Internally, running commands with `db.runCommand()` (page 853) is equivalent to a special query against the *$cmd* collection.

Many common commands have their own shell helpers or wrappers in the `mongo` (page 908) shell and drivers, such as the `db.isMaster()` (page 850) method in the `mongo` (page 908) JavaScript shell.

47.1.3 `admin` Database Commands

You must run some commands on the *admin database*. Normally, these operations resemble the followings:

```
use admin
db.runCommand( {buildInfo: 1} )
```

However, there's also a command helper that automatically runs the command in the context of the `admin` database:

```
db._adminCommand( {buildInfo: 1} )
```

47.1.4 Command Responses

All commands return, at minimum, a document with an `ok` field indicating whether the command has succeeded:

```
{ 'ok': 1 }
```

Failed commands return the `ok` field with a value of `0`.

47.2 Recover MongoDB Data following Unexpected Shutdown

If MongoDB does not shutdown cleanly [1] the on-disk representation of the data files will likely reflect an inconsistent state which could lead to data corruption. [2]

To prevent data inconsistency and corruption, always shut down the database cleanly and use the *durability journaling* (page 948). The journal writes data to disk every 100 milliseconds by default and ensures that MongoDB can recover to a consistent state even in the case of an unclean shutdown due to power loss or other system failure.

If you are *not* running as part of a *replica set* **and** do *not* have journaling enabled, use the following procedure to recover data that may be in an inconsistent state. If you are running as part of a replica set, you should *always* restore from a backup or restart the `mongod` (page 897) instance with an empty `dbpath` (page 947) and allow MongoDB to perform an initial sync to restore the data.

See Also:

The *Administration* (page 31) documents, including *Replica Set Syncing* (page 315), and the documentation on the `repair` (page 950), `repairpath` (page 950), and `journal` (page 948) settings.

47.2.1 Process

Indications

When you are aware of a `mongod` (page 897) instance running without journaling that stops unexpectedly **and** you're not running with replication, you should always run the repair operation before starting MongoDB again. If you're using replication, then restore from a backup and allow replication to perform an initial *sync* (page 315) to restore data.

If the `mongod.lock` file in the data directory specified by `dbpath` (page 947), `http://docs.mongodb.org/v2.2/data/db` by default, is *not* a zero-byte file, then `mongod` (page 897) will refuse to start, and you will find a message that contains the following line in your MongoDB log our output:

```
Unclean shutdown detected.
```

This indicates that you need to remove the lockfile and run repair. If you run repair when the `mongodb.lock` file exists without the *`mongod --repairpath`* (page 902) option, you will see a message that contains the following line:

[1] To ensure a clean shut down, use the *`mongod --shutdown`* (page 902) option, your control script, "Control-C" (when running `mongod` (page 897) in interactive mode,) or `kill $(pidof mongod)` or `kill -2 $(pidof mongod)`.

[2] You can also use the `db.collection.validate()` (page 844) method to test the integrity of a single collection. However, this process is time consuming, and without journaling you can safely assume that the data is in an invalid state and you should either run the repair operation or resync from an intact member of the replica set.

```
old lock file: /data/db/mongod.lock. probably means unclean shutdown
```

You must remove the lockfile **and** run the repair operation before starting the database normally using the following procedure:

Overview

Warning: Recovering a member of a replica set.
Do not use this procedure to recover a member of a *replica set*. Instead you should either restore from a *backup* (page 67) or perform an initial sync using data from an intact member of the set, as described in *Resyncing a Member of a Replica Set* (page 293).

There are two processes to repair data files that result from an unexpected shutdown:

1. Use the *--repair* (page 901) option in conjunction with the *--repairpath* (page 902) option. mongod (page 897) will read the existing data files, and write the existing data to new data files. This does not modify or alter the existing data files.

   You do not need to remove the mongod.lock file before using this procedure.

2. Use the *--repair* (page 901) option. mongod (page 897) will read the existing data files, write the existing data to new files and replace the existing, possibly corrupt, files with new files.

   You must remove the mongod.lock file before using this procedure.

Note: *--repair* (page 901) functionality is also available in the shell with the db.repairDatabase() (page 853) helper for the repairDatabase (page 787) command.

Procedures

To repair your data files using the *--repairpath* (page 902) option to preserve the original data files unmodified:

1. Start mongod (page 897) using *--repair* (page 901) to read the existing data files.

   ```
   mongod --dbpath /data/db --repair --repairpath /data/db0
   ```

   When this completes, the new repaired data files will be in the http://docs.mongodb.org/v2.2/data/db0 directory.

2. Start mongod (page 897) using the following invocation to point the dbpath (page 947) at http://docs.mongodb.org/v2.2/data/db0:

   ```
   mongod --dbpath /data/db0
   ```

   Once you confirm that the data files are operational you may delete or archive the data files in the http://docs.mongodb.org/v2.2/data/db directory.

To repair your data files without preserving the original files, do not use the *--repairpath* (page 902) option, as in the following procedure:

1. Remove the stale lock file:

   ```
   rm /data/db/mongod.lock
   ```

Replace `http://docs.mongodb.org/v2.2/data/db` with your `dbpath` (page 947) where your MongoDB instance's data files reside.

> **Warning:** After you remove the `mongod.lock` file you *must* run the `--repair` (page 901) process before using your database.

2. Start `mongod` (page 897) using `--repair` (page 901) to read the existing data files.

   ```
   mongod --dbpath /data/db --repair
   ```

   When this completes, the repaired data files will replace the original data files in the `http://docs.mongodb.org/v2.2/data/db` directory.

3. Start `mongod` (page 897) using the following invocation to point the `dbpath` (page 947) at `http://docs.mongodb.org/v2.2/data/db`:

   ```
   mongod --dbpath /data/db
   ```

47.2.2 `mongod.lock`

In normal operation, you should **never** remove the `mongod.lock` file and start `mongod` (page 897). Instead consider the one of the above methods to recover the database and remove the lock files. In dire situations you can remove the lockfile, and start the database using the possibly corrupt files, and attempt to recover data from the database; however, it's impossible to predict the state of the database in these situations.

If you are not running with journaling, and your database shuts down unexpectedly for *any* reason, you should always proceed *as if* your database is in an inconsistent and likely corrupt state. If at all possible restore from *backup* (page 67) or, if running as a *replica set*, restore by performing an initial sync using data from an intact member of the set, as described in *Resyncing a Member of a Replica Set* (page 293).

47.3 Manage `mongod` Processes

MongoDB runs as a standard program. You can start MongoDB from a command line by issuing the `mongod` (page 897) command and specifying options. For a list of options, see *mongod* (page 897). MongoDB can also run as a Windows service. For details, see *MongoDB as a Windows Service* (page 19). To install MongoDB, see *Installing MongoDB* (page 3).

The following examples assume the directory containing the `mongod` (page 897) process is in your system paths. The `mongod` (page 897) process is the primary database process that runs on an individual server. `mongos` (page 905) provides a coherent MongoDB interface equivalent to a `mongod` (page 897) from the perspective of a client. The `mongo` (page 908) binary provides the administrative shell.

This document page discusses the `mongod` (page 897) process; however, some portions of this document may be applicable to `mongos` (page 905) instances.

See Also:

Run-time Database Configuration (page 33), *mongod* (page 897), *mongos* (page 904), and *Configuration File Options* (page 944).

47.3.1 Start `mongod`

By default, MongoDB stores data in the `http://docs.mongodb.org/v2.2/data/db` directory. On Windows, MongoDB stores data in `C:\data\db`. On all platforms, MongoDB listens for connections from clients on

port 27017.

To start MongoDB using all defaults, issue the following command at the system shell:

```
mongod
```

Specify a Data Directory

If you want mongod (page 897) to store data files at a path *other than* http://docs.mongodb.org/v2.2/data/db you can specify a dbpath (page 947). The dbpath (page 947) must exist before you start mongod (page 897). If it does not exist, create the directory and the permissions so that mongod (page 897) can read and write data to this path. For more information on permissions, see the *security operations documentation* (page 90).

To specify a dbpath (page 947) for mongod (page 897) to use as a data directory, use the *--dbpath* (page 899) option. The following invocation will start a mongod (page 897) instance and store data in the http://docs.mongodb.org/v2.2/srv/mongodb path

```
mongod --dbpath /srv/mongodb/
```

Specify a TCP Port

Only a single process can listen for connections on a network interface at a time. If you run multiple mongod (page 897) processes on a single machine, or have other processes that must use this port, you must assign each a different port to listen on for client connections.

To specify a port to mongod (page 897), use the *--port* (page 898) option on the command line. The following command starts mongod (page 897) listening on port 12345:

```
mongod --port 12345
```

Use the default port number when possible, to avoid confusion.

Start mongod as a Daemon

To run a mongod (page 897) process as a daemon (i.e. fork (page 947),) *and* write its output to a log file, use the *--fork* (page 899) and *--logpath* (page 898) options. You must create the log directory; however, mongod (page 897) will create the log file if it does not exist.

The following command starts mongod (page 897) as a daemon and records log output to http://docs.mongodb.org/v2.2/var/log/mongodb.log.

```
mongod --fork --logpath /var/log/mongodb.log
```

Additional Configuration Options

For an overview of common configurations and common configuration deployments. configurations for common use cases, see *Run-time Database Configuration* (page 33).

47.3.2 Stop mongod

To stop a mongod (page 897) instance not running as a daemon, press Control+C. MongoDB stops when all ongoing operations are complete and does a clean exit, flushing and closing all data files.

To stop a mongod (page 897) instance running in the background or foreground, issue the shutdownServer() (page 854) helper in the mongo (page 908) shell. Use the following sequence:

1. To open the mongo (page 908) shell for a mongod (page 897) instance running on the default port of 27017, issue the following command:

   ```
   mongo
   ```

2. To switch to the admin database and shutdown the mongod (page 897) instance, issue the following commands:

   ```
   use admin
   db.shutdownServer()
   ```

You may only use db.shutdownServer() (page 854) when connected to the mongod (page 897) when authenticated to the admin database or on systems without authentication connected via the localhost interface.

Alternately, you can shut down the mongod (page 897) instance:

- using the *--shutdown* (page 902) option
- from a driver using the shutdown (page 795). For details, see the *drivers documentation* (page 435) for your driver.

mongod Shutdown and Replica Sets

If the mongod (page 897) is the *primary* in a *replica set*, the shutdown process for these mongod (page 897) instances has the following steps:

1. Check how up-to-date the *secondaries* are.
2. If no secondary is within 10 seconds of the primary, mongod (page 897) will return a message that it will not shut down. You can pass the shutdown (page 795) command a timeoutSecs argument to wait for a secondary to catch up.
3. If there is a secondary within 10 seconds of the primary, the primary will step down and wait for the secondary to catch up.
4. After 60 seconds or once the secondary has caught up, the primary will shut down.

If there is no up-to-date secondary and you want the primary to shut down, issue the shutdown (page 795) command with the force argument, as in the following mongo (page 908) shell operation:

```
db.adminCommand({shutdown : 1, force : true})
```

To keep checking the secondaries for a specified number of seconds if none are immediately up-to-date, issue shutdown (page 795) with the timeoutSecs argument. MongoDB will keep checking the secondaries for the specified number of seconds if none are immediately up-to-date. If any of the secondaries catch up within the allotted time, the primary will shut down. If no secondaries catch up, it will not shut down.

The following command issues shutdown (page 795) with timeoutSecs set to 5:

```
db.adminCommand({shutdown : 1, timeoutSecs : 5})
```

Alternately you can use the timeoutSecs argument with the shutdownServer() (page 854) method:

```
db.shutdownServer({timeoutSecs : 5})
```

47.3.3 Sending a UNIX INT or TERM Signal

You can cleanly stop `mongod` (page 897) using a `SIGINT` or `SIGTERM` signal on UNIX-like systems. Either `^C` for a non-daemon `mongod` (page 897) instance, `kill -2 <pid>`, or `kill -15 <pid>` will cleanly terminate the `mongod` (page 897) instance.

Terminating a `mongod` (page 897) instance that is **not** running with *journaling* with `kill -9 <pid>` (i.e. `SIGKILL`) will probably cause data corruption.

To recover data in situations where `mongod` (page 897) instances have not terminated cleanly *without journaling* see *Recover MongoDB Data following Unexpected Shutdown* (page 596).

47.4 Convert a Replica Set to a Replicated Sharded Cluster

47.4.1 Overview

Following this tutorial, you will convert a single 3-member replica set to a cluster that consists of 2 shards. Each shard will consist of an independent 3-member replica set.

The tutorial uses a test environment running on a local system UNIX-like system. You should feel encouraged to "follow along at home." If you need to perform this process in a production environment, notes throughout the document indicate procedural differences.

The procedure, from a high level, is as follows:

1. Create or select a 3-member replica set and insert some data into a collection.
2. Start the config databases and create a cluster with a single shard.
3. Create a second replica set with three new `mongod` (page 897) instances.
4. Add the second replica set as a shard in the cluster.
5. Enable sharding on the desired collection or collections.

47.4.2 Process

Install MongoDB according to the instructions in the *MongoDB Installation Tutorial* (page 3).

Deploy a Replica Set with Test Data

If have an existing MongoDB *replica set* deployment, you can omit the this step and continue from *Deploy Sharding Infrastructure* (page 603).

Use the following sequence of steps to configure and deploy a replica set and to insert test data.

1. Create the following directories for the first replica set instance, named `firstset`:
   - `http://docs.mongodb.org/v2.2/data/example/firstset1`
   - `http://docs.mongodb.org/v2.2/data/example/firstset2`
   - `http://docs.mongodb.org/v2.2/data/example/firstset3`

   To create directories, issue the following command:

   ```
   mkdir -p /data/example/firstset1 /data/example/firstset2 /data/example/firstset3
   ```

2. In a separate terminal window or GNU Screen window, start three mongod (page 897) instances by running each of the following commands:

```
mongod --dbpath /data/example/firstset1 --port 10001 --replSet firstset --oplogSize 700 --rest
mongod --dbpath /data/example/firstset2 --port 10002 --replSet firstset --oplogSize 700 --rest
mongod --dbpath /data/example/firstset3 --port 10003 --replSet firstset --oplogSize 700 --rest
```

Note: The *--oplogSize 700* (page 903) option restricts the size of the operation log (i.e. oplog) for each mongod (page 897) instance to 700MB. Without the *--oplogSize* (page 903) option, each mongod (page 897) reserves approximately 5% of the free disk space on the volume. By limiting the size of the oplog, each instance starts more quickly. Omit this setting in production environments.

---

3. In a mongo (page 908) shell session in a new terminal, connect to the mongodb instance on port 10001 by running the following command. If you are in a production environment, first read the note below.

```
mongo localhost:10001/admin
```

Note: Above and hereafter, if you are running in a production environment or are testing this process with mongod (page 897) instances on multiple systems, replace "localhost" with a resolvable domain, hostname, or the IP address of your system.

---

4. In the mongo (page 908) shell, initialize the first replica set by issuing the following command:

```
db.runCommand({"replSetInitiate" :
                    {"_id" : "firstset", "members" : [{"_id" : 1, "host" : "localhost:10001"},
                                                      {"_id" : 2, "host" : "localhost:10002"},
                                                      {"_id" : 3, "host" : "localhost:10003"}
             ]}})
{
        "info" : "Config now saved locally.  Should come online in about a minute.",
        "ok" : 1
}
```

5. In the mongo (page 908) shell, create and populate a new collection by issuing the following sequence of JavaScript operations:

```
use test
switched to db test
people = ["Marc", "Bill", "George", "Eliot", "Matt", "Trey", "Tracy", "Greg", "Steve", "Kristina
for(var i=0; i<1000000; i++){
                                name = people[Math.floor(Math.random()*people.length)];
                                user_id = i;
                                boolean = [true, false][Math.floor(Math.random()*2)];
                                added_at = new Date();
                                number = Math.floor(Math.random()*10001);
                                db.test_collection.save({"name":name, "user_id":user_id, "boolean":
                               }
```

The above operations add one million documents to the collection `test_collection`. This can take several minutes, depending on your system.

The script adds the documents in the following form:

```
{ "_id" : ObjectId("4ed5420b8fc1dd1df5886f70"), "name" : "Greg", "user_id" : 4, "boolean" : true, "a
```

Deploy Sharding Infrastructure

This procedure creates the three config databases that store the cluster's metadata.

Note: For development and testing environments, a single config database is sufficient. In production environments, use three config databases. Because config instances store only the *metadata* for the sharded cluster, they have minimal resource requirements.

---

1. Create the following data directories for three *config database* instances:

   - `http://docs.mongodb.org/v2.2/data/example/config1`
   - `http://docs.mongodb.org/v2.2/data/example/config2`
   - `http://docs.mongodb.org/v2.2/data/example/config3`

   Issue the following command at the system prompt:

   ```
   mkdir -p /data/example/config1 /data/example/config2 /data/example/config3
   ```

2. In a separate terminal window or GNU Screen window, start the config databases by running the following commands:

   ```
   mongod --configsvr --dbpath /data/example/config1 --port 20001
   mongod --configsvr --dbpath /data/example/config2 --port 20002
   mongod --configsvr --dbpath /data/example/config3 --port 20003
   ```

3. In a separate terminal window or GNU Screen window, start `mongos` (page 905) instance by running the following command:

   ```
   mongos --configdb localhost:20001,localhost:20002,localhost:20003 --port 27017 --chunkSize 1
   ```

   Note: If you are using the collection created earlier or are just experimenting with sharding, you can use a small `--chunkSize` (page 907) (1MB works well.) The default `chunkSize` (page 954) of 64MB means that your cluster must have 64MB of data before the MongoDB's automatic sharding begins working.

   In production environments, do not use a small shard size.

   The `configdb` (page 954) options specify the *configuration databases* (e.g. `localhost:20001`, `localhost:20002`, and `localhost:2003`). The `mongos` (page 905) instance runs on the default "MongoDB" port (i.e. `27017`), while the databases themselves are running on ports in the `30001` series. In the this example, you may omit the `--port 27017` (page 905) option, as `27017` is the default port.

4. Add the first shard in `mongos` (page 905). In a new terminal window or GNU Screen session, add the first shard, according to the following procedure:

   (a) Connect to the `mongos` (page 905) with the following command:

   ```
   mongo localhost:27017/admin
   ```

   (b) Add the first shard to the cluster by issuing the `addShard` (page 739) command:

   ```
   db.runCommand( { addShard : "firstset/localhost:10001,localhost:10002,localhost:10003" } )
   ```

   (c) Observe the following message, which denotes success:

   ```
   { "shardAdded" : "firstset", "ok" : 1 }
   ```

Deploy a Second Replica Set

This procedure deploys a second replica set. This closely mirrors the process used to establish the first replica set above, omitting the test data.

1. Create the following data directories for the members of the second replica set, named `secondset`:
   - `http://docs.mongodb.org/v2.2/data/example/secondset1`
   - `http://docs.mongodb.org/v2.2/data/example/secondset2`
   - `http://docs.mongodb.org/v2.2/data/example/secondset3`
2. In three new terminal windows, start three instances of `mongod` (page 897) with the following commands:

   ```
   mongod --dbpath /data/example/secondset1 --port 10004 --replSet secondset --oplogSize 700 --rest
   mongod --dbpath /data/example/secondset2 --port 10005 --replSet secondset --oplogSize 700 --rest
   mongod --dbpath /data/example/secondset3 --port 10006 --replSet secondset --oplogSize 700 --rest
   ```

   Note: As above, the second replica set uses the smaller `oplogSize` (page 952) configuration. Omit this setting in production environments.
3. In the `mongo` (page 908) shell, connect to one mongodb instance by issuing the following command:

   ```
   mongo localhost:10004/admin
   ```
4. In the `mongo` (page 908) shell, initialize the second replica set by issuing the following command:

   ```
   db.runCommand({"replSetInitiate" :
                       {"_id" : "secondset",
                        "members" : [{"_id" : 1, "host" : "localhost:10004"},
                                     {"_id" : 2, "host" : "localhost:10005"},
                                     {"_id" : 3, "host" : "localhost:10006"}
                ]}})

   {
        "info" : "Config now saved locally.  Should come online in about a minute.",
        "ok" : 1
   }
   ```
5. Add the second replica set to the cluster. Connect to the `mongos` (page 905) instance created in the previous procedure and issue the following sequence of commands:

   ```
   use admin
   db.runCommand( { addShard : "secondset/localhost:10004,localhost:10005,localhost:10006" } )
   ```

   This command returns the following success message:

   ```
   { "shardAdded" : "secondset", "ok" : 1 }
   ```
6. Verify that both shards are properly configured by running the `listShards` (page 774) command. View this and example output below:

   ```
   db.runCommand({listShards:1})
   {
          "shards" : [
                 {
                        "_id" : "firstset",
                        "host" : "firstset/localhost:10001,localhost:10003,localhost:10002"
                 },
   ```

```
                {
                        "_id" : "secondset",
                        "host" : "secondset/localhost:10004,localhost:10006,localhost:10005"
                }
        ],
        "ok" : 1
}
```

Enable Sharding

MongoDB must have *sharding* enabled on *both* the database and collection levels.

Enabling Sharding on the Database Level

Issue the `enableSharding` (page 755) command. The following example enables sharding on the "test" database:

```
db.runCommand( { enableSharding : "test" } )
{ "ok" : 1 }
```

Create an Index on the Shard Key

MongoDB uses the shard key to distribute documents between shards. Once selected, you cannot change the shard key. Good shard keys:

- have values that are evenly distributed among all documents,
- group documents that are often accessed at the same time into contiguous chunks, and
- allow for effective distribution of activity among shards.

Typically shard keys are compound, comprising of some sort of hash and some sort of other primary key. Selecting a shard key depends on your data set, application architecture, and usage pattern, and is beyond the scope of this document. For the purposes of this example, we will shard the "number" key. This typically would *not* be a good shard key for production deployments.

Create the index with the following procedure:

```
use test
db.test_collection.ensureIndex({number:1})
```

See Also:

The *Shard Key Overview* (page 365) and *Shard Key* (page 374) sections.

Shard the Collection

Issue the following command:

```
use admin
db.runCommand( { shardCollection : "test.test_collection", key : {"number":1} })
{ "collectionsharded" : "test.test_collection", "ok" : 1 }
```

The collection `test_collection` is now sharded!

Over the next few minutes the Balancer begins to redistribute chunks of documents. You can confirm this activity by switching to the `test` database and running `db.stats()` (page 855) or `db.printShardingStatus()` (page 852).

As clients insert additional documents into this collection, `mongos` (page 905) distributes the documents evenly between the shards.

In the `mongo` (page 908) shell, issue the following commands to return statics against each cluster:

```
use test
db.stats()
db.printShardingStatus()
```

Example output of the `db.stats()` (page 855) command:

```
{
     "raw" : {
              "firstset/localhost:10001,localhost:10003,localhost:10002" : {
                       "db" : "test",
                       "collections" : 3,
                       "objects" : 973887,
                       "avgObjSize" : 100.33173458522396,
                       "dataSize" : 97711772,
                       "storageSize" : 141258752,
                       "numExtents" : 15,
                       "indexes" : 2,
                       "indexSize" : 56978544,
                       "fileSize" : 1006632960,
                       "nsSizeMB" : 16,
                       "ok" : 1
              },
              "secondset/localhost:10004,localhost:10006,localhost:10005" : {
                       "db" : "test",
                       "collections" : 3,
                       "objects" : 26125,
                       "avgObjSize" : 100.33286124401914,
                       "dataSize" : 2621196,
                       "storageSize" : 11194368,
                       "numExtents" : 8,
                       "indexes" : 2,
                       "indexSize" : 2093056,
                       "fileSize" : 201326592,
                       "nsSizeMB" : 16,
                       "ok" : 1
              }
     },
     "objects" : 1000012,
     "avgObjSize" : 100.33176401883178,
     "dataSize" : 100332968,
     "storageSize" : 152453120,
     "numExtents" : 23,
     "indexes" : 4,
     "indexSize" : 59071600,
     "fileSize" : 1207959552,
     "ok" : 1
}
```

Example output of the `db.printShardingStatus()` (page 852) command:

```
--- Sharding Status ---
sharding version: { "_id" : 1, "version" : 3 }
shards:
       {  "_id" : "firstset",  "host" : "firstset/localhost:10001,localhost:10003,localhost:10002" }
       {  "_id" : "secondset",  "host" : "secondset/localhost:10004,localhost:10006,localhost:10005"
databases:
       {  "_id" : "admin",  "partitioned" : false,  "primary" : "config" }
       {  "_id" : "test",  "partitioned" : true,  "primary" : "firstset" }
                test.test_collection chunks:
                                                secondset     5
                                                firstset      186

[...]
```

In a few moments you can run these commands for a second time to demonstrate that *chunks* are migrating from `firstset` to `secondset`.

When this procedure is complete, you will have converted a replica set into a cluster where each shard is itself a replica set.

47.5 Copy Databases Between Instances

47.5.1 Synopsis

MongoDB provides the `copydb` (page 749) and `clone` (page 743) *database commands* to support migrations of entire logical databases between `mongod` (page 897) instances. With these commands you can copy data between instances with a simple interface without the need for an intermediate stage. The `db.cloneDatabase()` (page 815) and `db.copyDatabase()` (page 844) provide helpers for these operations in the `mongo` (page 908) shell.

Data migrations that require an intermediate stage or that involve more than one database instance are beyond the scope of this tutorial. `copydb` (page 749) and `clone` (page 743) are more ideal for use cases that resemble the following use cases:

- data migrations,
- data warehousing, and
- seeding test environments.

Also consider the *Backup Strategies for MongoDB Systems* (page 67) and *Importing and Exporting MongoDB Data* (page 63) documentation for more related information.

Note: `copydb` (page 749) and `clone` (page 743) do not produce point-in-time snapshots of the source database. Write traffic to the source or destination database during the copy process will result divergent data sets.

47.5.2 Considerations

- You must run `copydb` (page 749) or `clone` (page 743) on the destination server.
- You cannot use `copydb` (page 749) or `clone` (page 743) with databases that have a sharded collection in a *sharded cluster*, or any database via a `mongos` (page 905).
- You *can* use `copydb` (page 749) or `clone` (page 743) with databases that do not have sharded collections in a *cluster* when you're connected directly to the `mongod` (page 897) instance.

- You can run copydb (page 749) or clone (page 743) commands on a *secondary* member of a replica set, with properly configured *read preference*.
- Each destination mongod (page 897) instance must have enough free disk space on the destination server for the database you are copying. Use the db.stats() (page 855) operation to check the size of the database on the source mongod (page 897) instance. For more information on the output of db.stats() (page 855) see *Database Statistics Reference* (page 979) document.

47.5.3 Processes

Copy and Rename a Database

To copy a database from one MongoDB instance to another and rename the database in the process, use the copydb (page 749) command, or the db.copyDatabase() (page 844) helper in the mongo (page 908) shell.

Use the following procedure to copy the database named test on server db0.example.net to the server named db1.example.net and rename it to records in the process:

- Verify that the database, test exists on the source mongod (page 897) instance running on the db0.example.net host.
- Connect to the destination server, running on the db1.example.net host, using the mongo (page 908) shell.
- Model your operation on the following command:

```
db.copyDatabase( "test", "records", db0.example.net )
```

Rename a Database

You can also use copydb (page 749) or the db.copyDatabase() (page 844) helper to:

- rename a database within a single MongoDB instance or
- create a duplicate database for testing purposes.

Use the following procedure to rename the test database records on a single mongod (page 897) instance:

- Connect to the mongod (page 897) using the mongo (page 908) shell.
- Model your operation on the following command:

```
db.copyDatabase( "test", "records" )
```

Copy a Database with Authentication

To copy a database from a source MongoDB instance that has authentication enabled, you can specify authentication credentials to the copydb (page 749) command or the db.copyDatabase() (page 844) helper in the mongo (page 908) shell.

In the following operation, you will copy the test database from the mongod (page 897) running on db0.example.net to the records database on the local instance (e.g. db1.example.net.) Because the mongod (page 897) instance running on db0.example.net requires authentication for all connections, you will need to pass db.copyDatabase() (page 844) authentication credentials, as in the following procedure:

- Connect to the destination mongod (page 897) instance running on the db1.example.net host using the mongo (page 908) shell.
- Issue the following command:

```
db.copyDatabase( "test", "records", db0.example.net, "<username>", "<password>")
```

Replace `<username>` and `<password>` with your authentication credentials.

Clone a Database

The `clone` (page 743) command copies a database between `mongod` (page 897) instances like `copydb` (page 749); however, `clone` (page 743) preserves the database name from the source instance on the destination `mongod` (page 897).

For many operations, `clone` (page 743) is functionally equivalent to `copydb` (page 749), but it has a more simple syntax and a more narrow use. The `mongo` (page 908) shell provides the `db.cloneDatabase()` (page 815) helper as a wrapper around `clone` (page 743).

You can use the following procedure to clone a database from the `mongod` (page 897) instance running on `db0.example.net` to the `mongod` (page 897) running on `db1.example.net`:

- Connect to the destination `mongod` (page 897) instance running on the `db1.example.net` host using the `mongo` (page 908) shell.
- Issue the following command to specify the name of the database you want to copy:

  ```
  use records
  ```

- Use the following operation to initiate the `clone` (page 743) operation:

  ```
  db.cloneDatabase( "db0.example.net" )
  ```

47.6 Use `mongodump` and `mongorestore` to Backup and Restore MongoDB Databases

This document describes the process for writing the entire contents of your MongoDB instance to a file in a binary format. If disk-level snapshots are not available, this approach provides the best option for full system database backups. If your system has disk level snapshot capabilities, consider the backup methods described in *Use Filesystem Snapshots to Backup and Restore MongoDB Databases* (page 612).

See Also:

- *Backup Strategies for MongoDB Systems* (page 67)
- *mongodump* (page 914)
- *mongorestore* (page 917)

47.6.1 Backup a Database with `mongodump`

Basic `mongodump` Operations

The `mongodump` (page 915) utility can back up data by either:

- connecting to a running `mongod` (page 897) or `mongos` (page 905) instance, or
- accessing data files without an active instance.

The utility can create a backup for an entire server, database or collection, or can use a query to backup just part of a collection.

When you run mongodump (page 915) without any arguments, the command connects to the local database instance (e.g. 127.0.0.1 or localhost) on port 27017 and creates a database backup named dump/ in the current directory.

To backup data from a mongod (page 897) or mongos (page 905) instance running on the same machine and on the default port of 27017 use the following command:

```
mongodump
```

Note: The format of data created by mongodump (page 915) tool from the 2.2 distribution or later is different and incompatible with earlier versions of mongod (page 897).

To limit the amount of data included in the database dump, you can specify *--db* (page 916) and *--collection* (page 916) as options to the mongodump (page 915) command. For example:

```
mongodump --dbpath /data/db/ --out /data/backup/
```

```
mongodump --host mongodb.example.net --port 27017
```

mongodump (page 915) will write *BSON* files that hold a copy of data accessible via the mongod (page 897) listening on port 27017 of the mongodb.example.net host.

```
mongodump --collection collection --db test
```

This command creates a dump of the collection named collection from the database test in a dump/ subdirectory of the current working directory.

Point in Time Operation Using Oplogs

Use the *--oplog* (page 916) option with mongodump (page 915) to collect the *oplog* entries to build a point-in-time snapshot of a database within a replica set. With *--oplog* (page 916), mongodump (page 915) copies all the data from the source database as well as all of the *oplog* entries from the beginning of the backup procedure to until the backup procedure completes. This backup procedure, in conjunction with *mongorestore --oplogReplay* (page 919), allows you to restore a backup that reflects a consistent and specific moment in time.

Create Backups Without a Running mongod Instance

If your MongoDB instance is not running, you can use the *--dbpath* (page 915) option to specify the location to your MongoDB instance's database files. mongodump (page 915) reads from the data files directly with this operation. This locks the data directory to prevent conflicting writes. The mongod (page 897) process must *not* be running or attached to these data files when you run mongodump (page 915) in this configuration. Consider the following example:

```
mongodump --dbpath /srv/mongodb
```

Create Backups from Non-Local mongod Instances

The *--host* (page 915) and *--port* (page 915) options for mongodump (page 915) allow you to connect to and backup from a remote host. Consider the following example:

```
mongodump --host mongodb1.example.net --port 3017 --username user --password pass --out /opt/backup/m
```

On any mongodump (page 915) command you may, as above, specify username and password credentials to specify database authentication.

47.6.2 Restore a Database with mongorestore

The mongorestore (page 918) utility restores a binary backup created by mongodump (page 915). By default, mongorestore (page 918) looks for a database backup in the dump/ directory.

The mongorestore (page 918) utility can restore data either by:

- connecting to a running mongod (page 897) or mongos (page 905) directly, or
- writing to a local database path without use of a running mongod (page 897).

The mongorestore (page 918) utility can restore either an entire database backup or a subset of the backup.

A mongorestore (page 918) command that connects to an active mongod (page 897) or mongos (page 905) has the following prototype form:

```
mongorestore --port <port number> <path to the backup>
```

A mongorestore (page 918) command that writes to data files without using a running mongod (page 897) has the following prototype form:

```
mongorestore --dbpath <local database path> <path to the backup>
```

Consider the following example:

```
mongorestore dump-2012-10-25/
```

Here, mongorestore (page 918) imports the database backup in the dump-2012-10-25 directory to the mongod (page 897) instance running on the localhost interface.

Restore Point in Time Oplog Backup

If you created your database dump using the *--oplog* (page 916) option to ensure a point-in-time snapshot, call mongorestore (page 918) with the *--oplogReplay* (page 919) option, as in the following example:

```
mongorestore --oplogReplay
```

You may also consider using the *mongorestore --objcheck* (page 919) option to check the integrity of objects while inserting them into the database, or you may consider the *mongorestore --drop* (page 919) option to drop each collection from the database before restoring from backups.

Restore a Subset of data from a Binary Database Dump

mongorestore (page 918) also includes the ability to a filter to all input before inserting it into the new database. Consider the following example:

```
mongorestore --filter '{"field": 1}'
```

Here, mongorestore (page 918) only adds documents to the database from the dump located in the dump/ folder *if* the documents have a field name field that holds a value of 1. Enclose the filter in single quotes (e.g. ') to prevent the filter from interacting with your shell environment.

Restore without a Running mongod

mongorestore (page 918) can write data to MongoDB data files without needing to connect to a mongod (page 897) directly.

```
mongorestore --dbpath /srv/mongodb --journal
```

Here, mongorestore (page 918) restores the database dump located in dump/ folder into the data files located at http://docs.mongodb.org/v2.2/srv/mongodb. Additionally, the *--journal* (page 919) option ensures that mongorestore (page 918) records all operation in the durability *journal*. The journal prevents data file corruption if anything (e.g. power failure, disk failure, etc.) interrupts the restore operation.

See Also:

mongodump (page 914) and *mongorestore* (page 917).

Restore Backups to Non-Local mongod Instances

By default, mongorestore (page 918) connects to a MongoDB instance running on the localhost interface (e.g. 127.0.0.1) and on the default port (27017). If you want to restore to a different host or port, use the *--host* (page 918) and *--port* (page 918) options.

Consider the following example:

```
mongorestore --host mongodb1.example.net --port 3017 --username user --password pass /opt/backup/mong
```

As above, you may specify username and password connections if your mongod (page 897) requires authentication.

47.7 Use Filesystem Snapshots to Backup and Restore MongoDB Databases

This document describes a procedure for creating backups of MongoDB systems using system-level tools, such as *LVM* or storage appliance, as well as the corresponding restoration strategies.

These filesystem snapshots, or "block-level" backup methods use system level tools to create copies of the device that holds MongoDB's data files. These methods complete quickly and work reliably, but require more system configuration outside of MongoDB.

See Also:

Backup Strategies for MongoDB Systems (page 67) and *Use mongodump and mongorestore to Backup and Restore MongoDB Databases* (page 609).

47.7.1 Snapshots Overview

Snapshots work by creating pointers between the live data and a special snapshot volume. These pointers are theoretically equivalent to "hard links." As the working data diverges from the snapshot, the snapshot process uses a copy-on-write strategy. As a result the snapshot only stores modified data.

After making the snapshot, you mount the snapshot image on your file system and copy data from the snapshot. The resulting backup contains a full copy of all data.

Snapshots have the following limitations:

- The database must be in a consistent or recoverable state when the snapshot takes place. This means that all writes accepted by the database need to be fully written to disk: either to the *journal* or to data files.

  If all writes are not on disk when the backup occurs, the backup will not reflect these changes. If writes are *in progress* when the backup occurs, the data files will reflect an inconsistent state. With *journaling* all data-file states resulting from in-progress writes are recoverable; without journaling you must flush all pending writes to disk before running the backup operation and must ensure that no writes occur during the entire backup procedure.

  If you do use journaling, the journal **must** reside on the same volume as the data.

- Snapshots create an image of an entire disk image. Unless you need to back up your entire system, consider isolating your MongoDB data files, journal (if applicable), and configuration on one logical disk that doesn't contain any other data.

  Alternately, store all MongoDB data files on a dedicated device so that you can make backups without duplicating extraneous data.

- Ensure that you copy data from snapshots and onto other systems to ensure that data is safe from site failures.

- Although different snapshots methods provide different capability, the LVM method outlined below does not provide any capacity for capturing incremental backups.

Snapshots With Journaling

If your `mongod` (page 897) instance has journaling enabled, then you can use any kind of file system or volume/block level snapshot tool to create backups.

If you manage your own infrastructure on a Linux-based system, configure your system with *LVM* to provide your disk packages and provide snapshot capability. You can also use LVM-based setups *within* a cloud/virtualized environment.

Note: Running *LVM* provides additional flexibility and enables the possibility of using snapshots to back up MongoDB.

Snapshots with Amazon EBS in a RAID 10 Configuration

If your deployment depends on Amazon's Elastic Block Storage (EBS) with RAID configured within your instance, it is impossible to get a consistent state across all disks using the platform's snapshot tool. As an alternative, you can do one of the following:

- Flush all writes to disk and create a write lock to ensure consistent state during the backup process.

  If you choose this option see *Create Backups on Instances that do not have Journaling Enabled* (page 615).

- Configure *LVM* to run and hold your MongoDB data files on top of the RAID within your system.

  If you choose this option, perform the LVM backup operation described in *Create a Snapshot* (page 614).

47.7.2 Backup and Restore Using LVM on a Linux System

This section provides an overview of a simple backup process using *LVM* on a Linux system. While the tools, commands, and paths may be (slightly) different on your system the following steps provide a high level overview of the backup operation.

Note: Only use the following procedure as a guideline for a backup system and infrastructure. Production backup systems must consider a number of application specific requirements and factors unique to specific environments.

Create a Snapshot

To create a snapshot with *LVM*, issue a command as root in the following format:

```
lvcreate --size 100M --snapshot --name mdb-snap01 /dev/vg0/mongodb
```

This command creates an *LVM* snapshot (with the `--snapshot` option) named `mdb-snap01` of the `mongodb` volume in the `vg0` volume group.

This example creates a snapshot named `mdb-snap01` located at `http://docs.mongodb.org/v2.2/dev/vg0/mdb-snap01`. The location and paths to your systems volume groups and devices may vary slightly depending on your operating system's *LVM* configuration.

The snapshot has a cap of at 100 megabytes, because of the parameter `--size 100M`. This size does not reflect the total amount of the data on the disk, but rather the quantity of differences between the current state of `http://docs.mongodb.org/v2.2/dev/vg0/mongodb` and the creation of the snapshot (i.e. `http://docs.mongodb.org/v2.2/dev/vg0/mdb-snap01`.)

> **Warning:** Ensure that you create snapshots with enough space to account for data growth, particularly for the period of time that it takes to copy data out of the system or to a temporary image.
> If your snapshot runs out of space, the snapshot image becomes unusable. Discard this logical volume and create another.

The snapshot will exist when the command returns. You can restore directly from the snapshot at any time or by creating a new logical volume and restoring from this snapshot to the alternate image.

While snapshots are great for creating high quality backups very quickly, they are not ideal as a format for storing backup data. Snapshots typically depend and reside on the same storage infrastructure as the original disk images. Therefore, it's crucial that you archive these snapshots and store them elsewhere.

Archive a Snapshot

After creating a snapshot, mount the snapshot and move the data to separate storage. Your system might try to compress the backup images as you move the offline. The following procedure fully archives the data from the snapshot:

```
umount /dev/vg0/mdb-snap01
dd if=/dev/vg0/mdb-snap01 | gzip > mdb-snap01.gz
```

The above command sequence does the following:

- Ensures that the `http://docs.mongodb.org/v2.2/dev/vg0/mdb-snap01` device is not mounted.
- Performs a block level copy of the entire snapshot image using the `dd` command and compresses the result in a gzipped file in the current working directory.

  > **Warning:** This command will create a large `gz` file in your current working directory. Make sure that you run this command in a file system that has enough free space.

Restore a Snapshot

To restore a snapshot created with the above method, issue the following sequence of commands:

```
lvcreate --size 1G --name mdb-new vg0
gzip -d -c mdb-snap01.gz | dd of=/dev/vg0/mdb-new
mount /dev/vg0/mdb-new /srv/mongodb
```

The above sequence does the following:

- Creates a new logical volume named `mdb-new`, in the `http://docs.mongodb.org/v2.2/dev/vg0` volume group. The path to the new device will be `http://docs.mongodb.org/v2.2/dev/vg0/mdb-new`.

  Warning: This volume will have a maximum size of 1 gigabyte. The original file system must have had a total size of 1 gigabyte or smaller, or else the restoration will fail.
  Change `1G` to your desired volume size.

- Uncompresses and unarchives the `mdb-snap01.gz` into the `mdb-new` disk image.
- Mounts the `mdb-new` disk image to the `http://docs.mongodb.org/v2.2/srv/mongodb` directory. Modify the mount point to correspond to your MongoDB data file location, or other location as needed.

Note: The restored snapshot will have a stale `mongod.lock` file. If you do not remove this file from the snapshot, and MongoDB may assume that the stale lock file indicates an unclean shutdown. If you're running with `journal` (page 948) enabled, and you *do not* use `db.fsyncLock()` (page 848), you do not need to remove the `mongod.lock` file. If you use `db.fsyncLock()` (page 848) you will need to remove the lock.

Restore Directly from a Snapshot

To restore a backup without writing to a compressed `gz` file, use the following sequence of commands:

```
umount /dev/vg0/mdb-snap01
lvcreate --size 1G --name mdb-new vg0
dd if=/dev/vg0/mdb-snap01 of=/dev/vg0/mdb-new
mount /dev/vg0/mdb-new /srv/mongodb
```

Remote Backup Storage

You can implement off-system backups using the *combined process* (page 615) and SSH.

This sequence is identical to procedures explained above, except that it archives and compresses the backup on a remote system using SSH.

Consider the following procedure:

```
umount /dev/vg0/mdb-snap01
dd if=/dev/vg0/mdb-snap01 | ssh username@example.com gzip > /opt/backup/mdb-snap01.gz
lvcreate --size 1G --name mdb-new vg0
ssh username@example.com gzip -d -c /opt/backup/mdb-snap01.gz | dd of=/dev/vg0/mdb-new
mount /dev/vg0/mdb-new /srv/mongodb
```

47.7.3 Create Backups on Instances that do not have Journaling Enabled

If your `mongod` (page 897) instance does not run with journaling enabled, or if your journal is on a separate volume, obtaining a functional backup of a consistent state is more complicated. As described in this section, you must flush all writes to disk and lock the database to prevent writes during the backup process. If you have a *replica set* configuration, then for your backup use a *secondary* which is not receiving reads (i.e. *hidden member*).

1. To flush writes to disk and to "lock" the database (to prevent further writes), issue the `db.fsyncLock()` (page 848) method in the `mongo` (page 908) shell:

   ```
   db.fsyncLock();
   ```

2. Perform the backup operation described in *Create a Snapshot* (page 614).

3. To unlock the database after the snapshot has completed, use the following command in the `mongo` (page 908) shell:

   ```
   db.fsyncUnlock();
   ```

Note: Changed in version 2.0: MongoDB 2.0 added `db.fsyncLock()` (page 848) and `db.fsyncUnlock()` (page 848) helpers to the `mongo` (page 908) shell. Prior to this version, use the `fsync` (page 763) command with the `lock` option, as follows:

```
db.runCommand( { fsync: 1, lock: true } );
db.runCommand( { fsync: 1, lock: false } );
```

Note: The database cannot be locked with `db.fsyncLock()` (page 848) while profiling is enabled. You must disable profiling before locking the database with `db.fsyncLock()` (page 848). Disable profiling using `db.setProfilingLevel()` (page 854) as follows in the `mongo` (page 908) shell:

```
db.setProfilingLevel(0)
```

Warning: Changed in version 2.2: When used in combination with `fsync` (page 763) or `db.fsyncLock()` (page 848), `mongod` (page 897) may block some reads, including those from `mongodump` (page 915), when queued write operation waits behind the `fsync` (page 763) lock.

47.8 Analyze Performance of Database Operations

The database profiler collects fine grained data about MongoDB write operations, cursors, database commands on a running `mongod` (page 897) instance. You can enable profiling on a per-database or per-instance basis. The profiling *profiling level* (page 616) is also configurable when enabling profiling

The database profiler writes all the data it collects to the `system.profile` (page 1020) collection, which is a *capped collection* (page 440). See *Database Profiler Output* (page 1003) for overview of the data in the `system.profile` (page 1020) documents created by the profiler.

This document outlines a number of key administration options for the database profiler. For additional related information, consider the following resources:

- *Database Profiler Output* (page 1003)
- *Profile Command* (page 783)
- *Current Operation Reporting* (page 998)

47.8.1 Profiling Levels

The following profiling levels are available:

- `0` - the profiler is off, does not collect any data.

- 1 - collects profiling data for slow operations only. By default slow operations are those slower than 100 milliseconds.

  You can modify the threshold for "slow" operations with the slowms (page 950) runtime option or the setParameter (page 793) command. See the *Specify the Threshold for Slow Operations* (page 617) section for more information.

- 2 - collects profiling data for all database operations.

47.8.2 Enable Database Profiling and Set the Log Level

You can enable database profiling from the mongo (page 908) shell or through a driver using the profile (page 783) command. This section will describe how to do so from the mongo (page 908) shell. See your *driver documentation* (page 435) if you want to control the profiler from within your application.

When you enable profiling, you also set the *log level* (page 616). The profiler records data in the system.profile (page 1020) collection. MongoDB creates the system.profile (page 1020) collection in a database after you enable profiling for that database.

To enable profiling and set the log level, issue use the db.setProfilingLevel() (page 854) helper in the mongo (page 908) shell, passing the log level as a parameter. For example, to enable profiling for all database operations, consider the following operation in the mongo (page 908) shell:

```
db.setProfilingLevel(2)
```

The shell returns a document showing the *previous* level of profiling. The "ok" : 1 key-value pair indicates the operation succeeded:

```
{ "was" : 0, "slowms" : 100, "ok" : 1 }
```

To verify the new setting, see the *Check Profiling Level* (page 618) section.

Specify the Threshold for Slow Operations

The threshold for slow operations applies to the entire mongod (page 897) instance. When you change the threshold, you change it for all databases on the instance.

Important: Changing the slow operation threshold for the database profiler also affects the logging subsystem's slow operation threshold for the entire mongod (page 897) instance. Always set the threshold to the highest useful value.

By default the slow operation threshold is 100 milliseconds. Databases with a log level of 1 will log operations slower than 100 milliseconds.

To change the threshold, pass two parameters to the db.setProfilingLevel() (page 854) helper in the mongo (page 908) shell. The first parameter sets the log level for the current database, and the second sets the default slow operation threshold *for the entire* mongod (page 897) *instance*.

For example, the following command sets the log level for the current database to 0, which disables profiling, and sets the slow-operation threshold for the mongod (page 897) instance to 20 milliseconds. Any database on the instance with a log level of 1 will use this threshold:

```
db.setProfilingLevel(0,20)
```

Check Profiling Level

To view the *profiling level* (page 616), issue the following from the mongo (page 908) shell:

```
db.getProfilingStatus()
```

The shell returns a document similar to the following:

```
{ "was" : 0, "slowms" : 100 }
```

The was field indicates the current level of profiling.

The slowms field indicates how long an operation must exist in milliseconds for an operation to pass the "slow" threshold. MongoDB will log operations that take longer than the threshold if the profiling level is 1. This document returns the profiling level in the was field. For an explanation of log levels, see *Profiling Levels* (page 616).

To return only the log level, use the db.getProfilingLevel() (page 850) helper in the mongo (page 908) as in the following:

```
db.getProfilingLevel()
```

Disable Profiling

To disable profiling, use the following helper in the mongo (page 908) shell:

```
db.setProfilingLevel(0)
```

Enable Profiling for an Entire mongod Instance

For development purposes in testing environments, you can enable database profiling for an entire mongod (page 897) instance. The profiling level applies to all databases provided by the mongod (page 897) instance.

To enable profiling for a mongod (page 897) instance, pass the following parameters to mongod (page 897) at startup or within the *configuration file* (page 944):

```
mongod --profile=1 --slowms=15
```

This sets the profiling level to 1, which collects profiling data for slow operations only, and defines slow operations as those that last longer than 15 milliseconds.

See Also:

profile (page 949) and slowms (page 950).

Database Profiling and Sharding

You *cannot* enable profiling on a mongos (page 905) instance. To enable profiling in a shard cluster, you must enable profiling for each mongod (page 897) instance in the cluster.

47.8.3 View Profiler Data

The database profiler logs information about database operations in the system.profile (page 1020) collection.

To view log information, query the system.profile (page 1020) collection. To view example queries, see *Profiler Overhead* (page 620)

For an explanation of the output data, see *Database Profiler Output* (page 1003).

Example Profiler Data Queries

This section displays example queries to the `system.profile` (page 1020) collection. For an explanation of the query output, see *Database Profiler Output* (page 1003).

To return the most recent 10 log entries in the `system.profile` (page 1020) collection, run a query similar to the following:

```
db.system.profile.find().limit(10).sort( { ts : -1 } ).pretty()
```

To return all operations except command operations (*$cmd*), run a query similar to the following:

```
db.system.profile.find( { op: { $ne : 'command' } } ).pretty()
```

To return operations for a particular collection, run a query similar to the following. This example returns operations in the `mydb` database's `test` collection:

```
db.system.profile.find( { ns : 'mydb.test' } ).pretty()
```

To return operations slower than `5` milliseconds, run a query similar to the following:

```
db.system.profile.find( { millis : { $gt : 5 } } ).pretty()
```

To return information from a certain time range, run a query similar to the following:

```
db.system.profile.find(
                        {
                         ts : {
                                $gt : new ISODate("2012-12-09T03:00:00Z") ,
                                $lt : new ISODate("2012-12-09T03:40:00Z")
                               }
                        }
                       ).pretty()
```

The following example looks at the time range, suppresses the `user` field from the output to make it easier to read, and sorts the results by how long each operation took to run:

```
db.system.profile.find(
                        {
                          ts : {
                                 $gt : new ISODate("2011-07-12T03:00:00Z") ,
                                 $lt : new ISODate("2011-07-12T03:40:00Z")
                                }
                        },
                        { user : 0 }
                       ).sort( { millis : -1 } )
```

Show the Five Most Recent Events

On a database that has profiling enabled, the `show profile` helper in the `mongo` (page 908) shell displays the 5 most recent operations that took at least 1 millisecond to execute. Issue `show profile` from the `mongo` (page 908) shell, as follows:

```
show profile
```

47.8.4 Profiler Overhead

When enabled, profiling has a minor effect on performance. The `system.profile` (page 1020) collection is a *capped collection* with a default size of 1 megabyte. A collection of this size can typically store store several thousand profile documents, but some application may use more or less profiling data per operation.

To change the size of the `system.profile` (page 1020) collection, you must:

1. Disable profiling.
2. Drop the `system.profile` (page 1020) collection.
3. Create a new `system.profile` (page 1020) collection.
4. Re-enable profiling.

For example, to create a new `system.profile` (page 1020) collections that's `4000000` bytes, use the following sequence of operations in the `mongo` (page 908) shell:

```
db.setProfilingLevel(0)

db.system.profile.drop()

db.createCollection( "system.profile", { capped: true, size:4000000 } )

db.setProfilingLevel(1)
```

47.9 Rotate Log Files

47.9.1 Overview

Log rotation archives the current log file and starts a new one. Specifically, log rotation renames the current log file by appending the filename with a timestamp, [3] opens a new log file, and finally closes the old log. MongoDB will only rotate logs, when you use the `logRotate` (page 775) command, or issue the process a `SIGUSR1` signal as described in this procedure.

See Also:

For information on logging, see the *Process Logging* (page 58) section.

47.9.2 Procedure

The following steps create and rotate a log file:

1. Start a `mongod` (page 897) with verbose logging, with appending enabled, and with the following log file:

   ```
   mongod -v --logpath /var/log/mongodb/server1.log --logappend
   ```

2. In a separate terminal, list the matching files:

   ```
   ls /var/log/mongodb/server1.log*
   ```

   For results, you get:

   ```
   server1.log
   ```

[3] MongoDB renders this timestamp in UTC (GMT) and formatted as *ISODate*.

3. Rotate the log file using *one* of the following methods.

   - From the mongo (page 908) shell, issue the logRotate (page 775) command from the admin database:

     ```
     use admin
     db.runCommand( { logRotate : 1 } )
     ```

     This is the only available method to rotate log files on Windows systems.

   - From the UNIX shell, rotate logs for a single process by issuing the following command:

     ```
     kill -SIGUSR1 <mongod process id>
     ```

   - From the UNIX shell, rotate logs for all mongod (page 897) processes on a machine by issuing the following command:

     ```
     killall -SIGUSR1 mongod
     ```

4. List the matching files again:

   ```
   ls /var/log/mongodb/server1.log*
   ```

   For results you get something similar to the following. The timestamps will be different.

   ```
   server1.log  server1.log.2011-11-24T23-30-00
   ```

   The example results indicate a log rotation performed at exactly 11:30 pm on November 24th, 2011 UTC, which is the local time offset by the local time zone. The original log file is the one with the timestamp. The new log is server1.log file.

   If you issue a second logRotate (page 775) command an hour later, then an additional file would appear when listing matching files, as in the following example:

   ```
   server1.log  server1.log.2011-11-24T23-30-00  server1.log.2011-11-25T00-30-00
   ```

   This operation does not modify the server1.log.2011-11-24T23-30-00 file created earlier, while server1.log.2011-11-25T00-30-00 is the previous server1.log file, renamed. server1.log is a new, empty file that receives all new log output.

47.10 Build Old Style Indexes

Important: Use this procedure *only* if you **must** have indexes that are compatible with a version of MongoDB earlier than 2.0.

MongoDB version 2.0 introduced the {v:1} index format. MongoDB versions 2.0 and later support both the {v:1} format and the earlier {v:0} format.

MongoDB versions prior to 2.0, however, support only the {v:0} format. If you need to roll back MongoDB to a version prior to 2.0, you must *drop* and *re-create* your indexes.

To build pre-2.0 indexes, use the dropIndexes() (page 819) and ensureIndex() (page 819) methods. You *cannot* simply reindex the collection. When you reindex on versions that only support {v:0} indexes, the v fields in the index definition still hold values of 1, even though the indexes would now use the {v:0} format. If you were to upgrade again to version 2.0 or later, these indexes would not work.

Example

Suppose you rolled back from MongoDB 2.0 to MongoDB 1.8, and suppose you had the following index on the `items` collection:

```
{ "v" : 1, "key" : { "name" : 1 }, "ns" : "mydb.items", "name" : "name_1" }
```

The `v` field tells you the index is a `{v:1}` index, which is incompatible with version 1.8.

To drop the index, issue the following command:

```
db.items.dropIndex( { name : 1 } )
```

To recreate the index as a `{v:0}` index, issue the following command:

```
db.foo.ensureIndex( { name : 1 } , { v : 0 } )
```

See Also:

Index Performance Enhancements (page 1048).

47.11 Replica Sets

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47.12 Sharding

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CHAPTER 50

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CHAPTER 51

MongoDB Use Case Studies

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Part XIII

Frequently Asked Questions

CHAPTER 52

FAQ: MongoDB Fundamentals

This document addresses basic high level questions about MongoDB and it's use.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List.

Frequently Asked Questions:

- What kind of database is MongoDB? (page 635)
- Do MongoDB databases have tables? (page 636)
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- What languages can I use to work with the MongoDB? (page 636)
- Does MongoDB support SQL? (page 636)
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- Does MongoDB support transactions? (page 637)
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- Are writes written to disk immediately, or lazily? (page 638)
- What language is MongoDB written in? (page 638)
- What are the limitations of 32-bit versions of MongoDB? (page 638)

52.1 What kind of database is MongoDB?

MongoDB is *document*-oriented DBMS. Think of MySQL but with *JSON*-like objects comprising the data model, rather than RDBMS tables. Significantly, MongoDB supports neither joins nor transactions. However, it features secondary indexes, an expressive query language, atomic writes on a per-document level, and fully-consistent reads.

Operationally, MongoDB features master-slave replication with automated failover and built-in horizontal scaling via automated range-based partitioning.

Note: MongoDB uses *BSON*, a binary object format similar to, but more expressive than, *JSON*.

52.2 Do MongoDB databases have tables?

Instead of tables, a MongoDB database stores its data in *collections*, which are the rough equivalent of RDBMS tables. A collection holds one or more *documents*, which corresponds to a record or a row in a relational database table, and each document has one or more fields, which corresponds to a column in a relational database table.

Collections have important differences from RDBMS tables. Documents in a single collection may have a unique combination and set of fields. Documents need not have identical fields. You can add a field to some documents in a collection without adding that field to all documents in the collection.

See Also:

SQL to MongoDB Mapping Chart (page 874)

52.3 Do MongoDB databases have schemas?

MongoDB uses dynamic schemas. You can create collections without defining the structure, i.e. the fields or the types of their values, of the documents in the collection. You can change the structure of documents simply by adding new fields or deleting existing ones. Documents in a collection need not have an identical set of fields.

In practice, it is common for a the documents in a collection to have a largely homogeneous structure; however, this is not a requirement. MongoDB's flexible schemas mean that schema migration and augmentation are very easy in practice, and you will rarely, if ever, need to write scripts that perform "alter table" type operations, which simplifies and facilitates iterative software development with MongoDB.

See Also:

SQL to MongoDB Mapping Chart (page 874)

52.4 What languages can I use to work with the MongoDB?

MongoDB *client drivers* exist for all of the most popular programming languages, and many of the less popular ones. See the latest list of drivers for details.

See Also:

"*MongoDB Drivers and Client Libraries* (page 435)."

52.5 Does MongoDB support SQL?

No.

However, MongoDB does support a rich, ad-hoc query language of its own.

See Also:

The *Query, Update, and Projection Operators Quick Reference* (page 882) and the *Query Overview* (page 882) pages.

52.6 What are typical uses for MongoDB?

MongoDB has a general-purpose design, making it appropriate for a large number of use cases. Examples include content management systems, mobile app, gaming, e-commerce, analytics, archiving, and logging.

Do not use MongoDB for systems that require SQL, joins, and multi-object transactions.

52.7 Does MongoDB support transactions?

MongoDB does not provide ACID transactions.

However, MongoDB does provide some basic transactional capabilities. Atomic operations are possible within the scope of a single document: that is, we can debit `a` and credit `b` as a transaction if they are fields within the same document. Because documents can be rich, some documents contain thousands of fields, with support for testing fields in sub-documents.

Additionally, you can make writes in MongoDB durable (the 'D' in ACID). To get durable writes, you must enable journaling, which is on by default in 64-bit builds. You must also issue writes with a write concern of `{j: true}` to ensure that the writes block until the journal has synced to disk.

Users have built successful e-commerce systems using MongoDB, but application requiring multi-object commit with rollback generally aren't feasible.

52.8 Does MongoDB require a lot of RAM?

Not necessarily. It's certainly possible to run MongoDB on a machine with a small amount of free RAM.

MongoDB automatically uses all free memory on the machine as its cache. System resource monitors show that MongoDB uses a lot of memory, but it's usage is dynamic. If another process suddenly needs half the server's RAM, MongoDB will yield cached memory to the other process.

Technically, the operating system's virtual memory subsystem manages MongoDB's memory. This means that MongoDB will use as much free memory as it can, swapping to disk as needed. Deployments with enough memory to fit the application's working data set in RAM will achieve the best performance.

See Also:

FAQ: MongoDB Diagnostics (page 683) for answers to additional questions about MongoDB and Memory use.

52.9 How do I configure the cache size?

MongoDB has no configurable cache. MongoDB uses all *free* memory on the system automatically by way of memory-mapped files. Operating systems use the same approach with their file system caches.

52.10 Does MongoDB require a separate caching layer for application-level caching?

No. In MongoDB, a document's representation in the database is similar to its representation in application memory. This means the database already stores the usable form of data, making the data usable in both the persistent store and in the application cache. This eliminates the need for a separate caching layer in the application.

This differs from relational databases, where caching data is more expensive. Relational databases must transform data into object representations that applications can read and must store the transformed data in a separate cache: if these transformation from data to application objects require joins, this process increases the overhead related to using the database which increases the importance of the caching layer.

52.11 Does MongoDB handle caching?

Yes. MongoDB keeps all of the most recently used data in RAM. If you have created indexes for your queries and your working data set fits in RAM, MongoDB serves all queries from memory.

MongoDB does not implement a query cache: MongoDB serves all queries directly from the indexes and/or data files.

52.12 Are writes written to disk immediately, or lazily?

Writes are physically written to the *journal* (page 41) within 100 milliseconds. At that point, the write is "durable" in the sense that after a pull-plug-from-wall event, the data will still be recoverable after a hard restart.

While the journal commit is nearly instant, MongoDB writes to the data files lazily. MongoDB may wait to write data to the data files for as much as one minute by default. This does not affect durability, as the journal has enough information to ensure crash recovery. To change the interval for writing to the data files, see `syncdelay` (page 951).

52.13 What language is MongoDB written in?

MongoDB is implemented in C++. *Drivers* and client libraries are typically written in their respective languages, although some drivers use C extensions for better performance.

52.14 What are the limitations of 32-bit versions of MongoDB?

MongoDB uses *memory-mapped files* (page 673). When running a 32-bit build of MongoDB, the total storage size for the server, including data and indexes, is 2 gigabytes. For this reason, do not deploy MongoDB to production on 32-bit machines.

If you're running a 64-bit build of MongoDB, there's virtually no limit to storage size. For production deployments, 64-bit builds and operating systems are strongly recommended.

See Also:

"Blog Post: 32-bit Limitations"

Note: 32-bit builds disable *journaling* by default because journaling further limits the maximum amount of data that the database can store.

CHAPTER 53

FAQ: MongoDB for Application Developers

This document answers common questions about application development using MongoDB.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List.

Frequently Asked Questions:

- What is a namespace in MongoDB? (page 640)
- How do you copy all objects from one collection to another? (page 640)
- If you remove a document, does MongoDB remove it from disk? (page 640)
- When does MongoDB write updates to disk? (page 640)
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- How do you aggregate data with MongoDB? (page 641)
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- When should I embed documents within other documents? (page 647)
- Can I manually pad documents to prevent moves during updates? (page 648)

53.1 What is a namespace in MongoDB?

A "namespace" is the concatenation of the *database* name and the *collection* names with a period character in between.

Collections are containers for documents that share one or more indexes. Databases are groups of collections stored on disk using a single set of data files.

For an example `acme.users` namespace, `acme` is the database name and `users` is the collection name. Period characters **can** occur in collection names, so that the `acme.user.history` is a valid namespace, with the `acme` database name, and the `user.history` collection name.

While data models like this appear to support nested collections, the collection namespace is flat, and there is no difference from the perspective of MongoDB between `acme`, `acme.users`, and `acme.records`.

53.2 How do you copy all objects from one collection to another?

In the `mongo` (page 908) shell, you can use the following operation to duplicate the entire collection:

```
db.people.find().forEach( function(x){db.user.insert(x)} );
```

Note: Because this process decodes *BSON* documents to *JSON* during the copy procedure, documents you may incur a loss of type-fidelity.

Consider using `mongodump` (page 915) and `mongorestore` (page 918) to maintain type fidelity.

Also consider the `cloneCollection` (page 743) *command* that may provide some of this functionality.

53.3 If you remove a document, does MongoDB remove it from disk?

Yes.

When you use `db.collection.remove()` (page 838), the object will no longer exist in MongoDB's on-disk data storage.

53.4 When does MongoDB write updates to disk?

MongoDB flushes writes to disk on a regular interval. In the default configuration, MongoDB writes data to the main data files on disk every 60 seconds and commits the *journal* every 100 milliseconds. These values are configurable with the `journalCommitInterval` (page 948) and `syncdelay` (page 951).

These values represent the *maximum* amount of time between the completion of a write operation and the point when the write is durable in the journal, if enabled, and when MongoDB flushes data to the disk. In many cases MongoDB and the operating system flush data to disk more frequently, so that the above values resents a theoretical maximum.

However, by default, MongoDB uses a "lazy" strategy to write to disk. This is advantageous in situations where the database receives a thousand increments to an object within one second, MongoDB only needs to flush this data to disk once. In addition to the aforementioned configuration options, you can also use `fsync` (page 763) and `getLastError` (page 766) to modify this strategy.

53.5 How do I do transactions and locking in MongoDB?

MongoDB does not have support for traditional locking or complex transactions with rollback. MongoDB aims to be lightweight, fast, and predictable in its performance. This is similar to the MySQL MyISAM autocommit model. By keeping transaction support extremely simple, MongoDB can provide greater performance especially for *partitioned* or *replicated* systems with a number of database server processes.

MongoDB *does* have support for atomic operations *within* a single document. Given the possibilities provided by nested documents, this feature provides support for a large number of use-cases.

See Also:

The *Isolate Sequence of Operations* (page 453) page.

53.6 How do you aggregate data with MongoDB?

In version 2.1 and later, you can use the new "*aggregation framework* (page 195)," with the `aggregate` (page 740) command.

MongoDB also supports *map-reduce* with the `mapReduce` (page 775), as well as basic aggregation with the `group` (page 769), `count` (page 750), and `distinct` (page 753). commands.

See Also:

The *Aggregation* (page 193) page.

53.7 Why does MongoDB log so many "Connection Accepted" events?

If you see a very large number connection and re-connection messages in your MongoDB log, then clients are frequently connecting and disconnecting to the MongoDB server. This is normal behavior for applications that do not use request pooling, such as CGI. Consider using FastCGI, an Apache Module, or some other kind of persistent application server to decrease the connection overhead.

If these connections do not impact your performance you can use the run-time `quiet` (page 951) option or the command-line option `--quiet` (page 898) to suppress these messages from the log.

53.8 Does MongoDB run on Amazon EBS?

Yes.

MongoDB users of all sizes have had a great deal of success using MongoDB on the EC2 platform using EBS disks.

See Also:

Amazon EC2

53.9 Why are MongoDB's data files so large?

MongoDB aggressively preallocates data files to reserve space and avoid file system fragmentation. You can use the `smallfiles` (page 950) flag to modify the file preallocation strategy.

See Also:

Why are the files in my data directory larger than the data in my database? (page 675)

53.10 How do I optimize storage use for small documents?

Each MongoDB document contains a certain amount of overhead. This overhead is normally insignificant but becomes significant if all documents are just a few bytes, as might be the case if the documents in your collection only have one or two fields.

Consider the following suggestions and strategies for optimizing storage utilization for these collections:

- Use the `_id` field explicitly.

  MongoDB clients automatically add an `_id` field to each document and generate a unique 12-byte *ObjectId* for the `_id` field. Furthermore, MongoDB always indexes the `_id` field. For smaller documents this may account for a significant amount of space.

  To optimize storage use, users can specify a value for the `_id` field explicitly when inserting documents into the collection. This strategy allows applications to store a value in the `_id` field that would have occupied space in another portion of the document.

  You can store any value in the `_id` field, but because this value serves as a primary key for documents in the collection, it must uniquely identify them. If the field's value is not unique, then it cannot serve as a primary key as there would be collisions in collection.

- Use shorter field names.

  MongoDB stores all field names in every document. For most documents, this represents a small fraction of the space used by a document; however, for small documents the field names may represent a proportionally large amount of space. Consider a collection of documents that resemble the following:

  ```
  { last_name : "Smith", best_score: 3.9 }
  ```

  If you shorten the filed named `last_name` to `lname` and the field name `best_score` to `score`, as follows, you could save 9 bytes per document.

  ```
  { lname : "Smith", score : 3.9 }
  ```

  Shortening field names reduces expressiveness and does not provide considerable benefit on for larger documents and where document overhead is not significant concern. Shorter field names do not reduce the size of indexes, because indexes have a predefined structure.

  In general it is not necessary to use short field names.

- Embed documents.

  In some cases you may want to embed documents in other documents and save on the per-document overhead.

53.11 When should I use GridFS?

For documents in a MongoDB collection, you should always use *GridFS* for storing files larger than 16 MB.

In some situations, storing large files may be more efficient in a MongoDB database than on a system-level filesystem.

- If your filesystem limits the number of files in a directory, you can use GridFS to store as many files as needed.

- When you want to keep your files and metadata automatically synced and deployed across a number of systems and facilities. When using *geographically distributed replica sets* (page 301) MongoDB can distribute files and their metadata automatically to a number of `mongod` (page 897) instances and facilities.
- When you want to access information from portions of large files without having to load whole files into memory, you can use GridFS to recall sections of files without reading the entire file into memory.

Do not use GridFS if you need to update the content of the entire file atomically. As an alternative you can store multiple versions of each file and specify the current version of the file in the metadata. You can update the metadata field that indicates "latest" status in an atomic update after uploading the new version of the file, and later remove previous versions if needed.

Furthermore, if your files are all smaller the 16 MB `BSON Document Size` (page 1021) limit, consider storing the file manually within a single document. You may use the BinData data type to store the binary data. See your *drivers* (page 435) documentation for details on using BinData.

For more information on GridFS, see *GridFS* (page 146).

53.12 How does MongoDB address SQL or Query injection?

53.12.1 BSON

As a client program assembles a query in MongoDB, it builds a BSON object, not a string. Thus traditional SQL injection attacks are not a problem. More details and some nuances are covered below.

MongoDB represents queries as *BSON* objects. Typically *client libraries* (page 435) provide a convenient, injection free, process to build these objects. Consider the following C++ example:

```
BSONObj my_query = BSON( "name" << a_name );
auto_ptr<DBClientCursor> cursor = c.query("tutorial.persons", my_query);
```

Here, `my_query` then will have a value such as `{ name : "Joe" }`. If `my_query` contained special characters, for example `,`, `:`, and `{`, the query simply wouldn't match any documents. For example, users cannot hijack a query and convert it to a delete.

53.12.2 JavaScript

Note: You can disable all server-side execution of JavaScript, by passing the `--noscripting` (page 901) option on the command line or setting `noscripting` (page 949) in a configuration file.

All of the following MongoDB operations permit you to run arbitrary JavaScript expressions directly on the server:- `$where` (page 720):

- `$where` (page 720)
- `db.eval()` (page 846)
- `mapReduce` (page 775)
- `group` (page 769)

You must exercise care in these cases to prevent users from submitting malicious JavaScript.

Fortunately, you can express most queries in MongoDB without JavaScript and for queries that require JavaScript, you can mix JavaScript and non-JavaScript in a single query. Place all the user-supplied fields directly in a *BSON* field and pass JavaScript code to the `$where` (page 720) field.

- If you need to pass user-supplied values in a $where (page 720) clause, you may escape these values with the CodeWScope mechanism. When you set user-submitted values as variables in the scope document, you can avoid evaluating them on the database server.
- If you need to use db.eval() (page 846) with user supplied values, you can either use a CodeWScope or you can supply extra arguments to your function. For instance:

```
db.eval(function(userVal){...},
        user_value);
```

  This will ensure that your application sends user_value to the database server as data rather than code.

53.12.3 Dollar Sign Operator Escaping

Field names in MongoDB's query language have a semantic. The dollar sign (i.e $) is a reserved character used to represent *operators* (page 882) (i.e. $inc (page 699).) Thus, you should ensure that your application's users cannot inject operators into their inputs.

In some cases, you may wish to build a BSON object with a user-provided key. In these situations, keys will need to substitute the reserved $ and . characters. Any character is sufficient, but consider using the Unicode full width equivalents: U+FF04 (i.e. "$") and U+FF0E (i.e. ".").

Consider the following example:

```
BSONObj my_object = BSON( a_key << a_name );
```

The user may have supplied a $ value in the a_key value. At the same time, my_object might be { $where : "things" }. Consider the following cases:

- **Insert**. Inserting this into the database does no harm. The insert process does not evaluate the object as a query.

  Note: MongoDB client drivers, if properly implemented, check for reserved characters in keys on inserts.

- **Update**. The db.collection.update() (page 842) operation permits $ operators in the update argument but does not support the $where (page 720) operator. Still, some users may be able to inject operators that can manipulate a single document only. Therefore your application should escape keys, as mentioned above, if reserved characters are possible.
- **Query** Generally this is not a problem for queries that resemble { x : user_obj }: dollar signs are not top level and have no effect. Theoretically it may be possible for the user to build a query themselves. But checking the user-submitted content for $ characters in key names may help protect against this kind of injection.

53.12.4 Driver-Specific Issues

See the "PHP MongoDB Driver Security Notes" page in the PHP driver documentation for more information

53.13 How does MongoDB provide concurrency?

MongoDB implements a readers-writer lock. This means that at any one time, only one client may be writing or any number of clients may be reading, but that reading and writing cannot occur simultaneously.

In standalone and *replica sets* the lock's scope applies to a single mongod (page 897) instance or *primary* instance. In a sharded cluster, locks apply to each individual shard, not to the whole cluster.

For more information, see *FAQ: Concurrency* (page 653).

53.14 What is the compare order for BSON types?

MongoDB permits documents within a single collection to have fields with different *BSON* types. For instance, the following documents may exist within a single collection.

```
{ x: "string" }
{ x: 42 }
```

When comparing values of different *BSON* types, MongoDB uses the following comparison order, from lowest to highest:

1. MinKey (internal type)
2. Null
3. Numbers (ints, longs, doubles)
4. Symbol, String
5. Object
6. Array
7. BinData
8. ObjectID
9. Boolean
10. Date, Timestamp
11. Regular Expression
12. MaxKey (internal type)

Note: MongoDB treats some types as equivalent for comparison purposes. For instance, numeric types undergo conversion before comparison.

Consider the following `mongo` (page 908) example:

```
db.test.insert( {x : 3 } );
db.test.insert( {x : 2.9 } );
db.test.insert( {x : new Date() } );
db.test.insert( {x : true } );

db.test.find().sort({x:1});
{ "_id" : ObjectId("4b03155dce8de6586fb002c7"), "x" : 2.9 }
{ "_id" : ObjectId("4b03154cce8de6586fb002c6"), "x" : 3 }
{ "_id" : ObjectId("4b031566ce8de6586fb002c9"), "x" : true }
{ "_id" : ObjectId("4b031563ce8de6586fb002c8"), "x" : "Tue Nov 17 2009 16:28:03 GMT-0500 (EST)" }
```

The `$type` (page 718) operator provides access to *BSON type* comparison in the MongoDB query syntax. See the documentation on *BSON types* and the `$type` (page 718) operator for additional information.

Warning: Storing values of the different types in the same field in a collection is *strongly* discouraged.

See Also:

- The *Tailable Cursors* (page 451) page for an example of a C++ use of `MinKey`.

53.15 How do I query for fields that have null values?

Fields in a document may store `null` values, as in a notional collection, `test`, with the following documents:

```
{ _id: 1, cancelDate: null }
{ _id: 2 }
```

Different query operators treat `null` values differently:

- The `{ cancelDate : null }` query matches documents that either contains the `cancelDate` field whose value is `null` *or* that do not contain the `cancelDate` field:

  ```
  db.test.find( { cancelDate: null } )
  ```

  The query returns both documents:

  ```
  { "_id" : 1, "cancelDate" : null }
  { "_id" : 2 }
  ```

- The `{ cancelDate : { $type: 10 } }` query matches documents that contains the `cancelDate` field whose value is `null` *only*; i.e. the value of the `cancelDate` field is of BSON Type `Null` (i.e. `10`) :

  ```
  db.test.find( { cancelDate : { $type: 10 } } )
  ```

  The query returns only the document that contains the `null` value:

  ```
  { "_id" : 1, "cancelDate" : null }
  ```

- The `{ cancelDate : { $exists: false } }` query matches documents that do not contain the `cancelDate` field:

  ```
  db.test.find( { cancelDate : { $exists: false } } )
  ```

  The query returns only the document that does *not* contain the `cancelDate` field:

  ```
  { "_id" : 2 }
  ```

See Also:

The reference documentation for the `$type` (page 718) and `$exists` (page 695) operators.

53.16 Are there any restrictions on the names of Collections?

Collection names can be any UTF-8 string with the following exceptions:

- A collection name should begin with a letter or an underscore.
- The empty string (`""`) is not a valid collection name.
- Collection names cannot contain the `$` character. (version 2.2 only)
- Collection names cannot contain the null character: `\0`
- Do not name a collection using the `system.` prefix. MongoDB reserves `system.` for system collections, such as the `system.indexes` collection.

- The maximum size of a collection name is 128 characters, including the name of the database. However, for maximum flexibility, collections should have names less than 80 characters.

If your collection name includes special characters, such as the underscore character, then to access the collection use the `db.getCollection()` (page 848) method or a similar method for your driver.

Example

To create a collection `_foo` and insert the `{ a : 1 }` document, use the following operation:

```
db.getCollection("_foo").insert( { a : 1 } )
```

To perform a query, use the `find()` (page 820) find method, in as the following:

```
db.getCollection("_foo").find()
```

53.17 How do I isolate cursors from intervening write operations?

MongoDB cursors can return the same document more than once in some situations. [1] You can use the `snapshot()` (page 812) method on a cursor to isolate the operation for a very specific case.

`snapshot()` (page 812) traverses the index on the `_id` field and guarantees that the query will return each document (with respect to the value of the `_id` field) no more than once. [2]

The `snapshot()` (page 812) does not guarantee that the data returned by the query will reflect a single moment in time *nor* does it provide isolation from insert or delete operations..

Warning:
- You **cannot** use `snapshot()` (page 812) with *sharded collections*.
- You **cannot** use `snapshot()` (page 812) with `sort()` (page 813) or `hint()` (page 806) cursor methods.

As an alternative, if your collection has a field or fields that are never modified, you can use a *unique* index on this field or these fields to achieve a similar result as the `snapshot()` (page 812). Query with `hint()` (page 806) to explicitly force the query to use that index.

53.18 When should I embed documents within other documents?

When *modeling data in MongoDB* (page 131), embedding is frequently the choice for:

- "contains" relationships between entities.
- one-to-many relationships when the "many" objects *always* appear with or are viewed in the context of their parents.

You should also consider embedding for performance reasons if you have a collection with a large number of small documents. Nevertheless, if small, separate documents represent the natural model for the data, then you should maintain that model.

[1] As a cursor returns documents other operations may interleave with the query: if some of these operations are *updates* (page 169) that cause the document to move (in the case of a table scan, caused by document growth,) or that change the indexed field on the index used by the query; then the cursor will return the same document more than once.

[2] MongoDB does not permit changes to the value of the `_id` field; it is not possible for a cursor that transverses this index to pass the same document more than once.

If, however, you can group these small documents by some logical relationship *and* you frequently retrieve the documents by this grouping, you might consider "rolling-up" the small documents into larger documents that contain an array of subdocuments. Keep in mind that if you often only need to retrieve a subset of the documents within the group, then "rolling-up" the documents may not provide better performance.

"Rolling up" these small documents into logical groupings means that queries to retrieve a group of documents involve sequential reads and fewer random disk accesses.

Additionally, "rolling up" documents and moving common fields to the larger document benefit the index on these fields. There would be fewer copies of the common fields *and* there would be fewer associated key entries in the corresponding index. See *Indexing Overview* (page 241) for more information on indexes.

53.19 Can I manually pad documents to prevent moves during updates?

An update can cause a document to move on disk if the document grows in size. To *minimize* document movements, MongoDB uses *padding* (page 127).

You should not have to pad manually because MongoDB adds *padding automatically* (page 127) and can adaptively adjust the amount of padding added to documents to prevent document relocations following updates.

You can change the default `paddingFactor` (page 982) calculation by using the the `collMod` (page 744) command with the `usePowerOf2Sizes` (page 744) flag. The `usePowerOf2Sizes` (page 744) flag ensures that MongoDB allocates document space in sizes that are powers of 2, which helps ensure that MongoDB can efficiently reuse free pace created by document deletion or relocation.

However, in those exceptions where you must pad manually, you can use the strategy of first adding a temporary field to a document and then `$unset` (page 720) the field, as in the following example:

```
var myTempPadding = [ "aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa",
                      "aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa",
                      "aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa",
                      "aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa"];

db.myCollection.insert( { _id: 5, paddingField: myTempPadding } );

db.myCollection.update( { _id: 5 },
                        { $unset: { paddingField: "" } }
                      )

db.myCollection.update( { _id: 5 },
                        { $set: { realField: "Some text that I might have needed padding for" } }
                      )
```

See Also:

Padding Factor (page 127)

CHAPTER 54

FAQ: The mongo Shell

Frequently Asked Questions:

- How can I enter multi-line operations in the mongo shell? (page 649)
- How can I access to different databases temporarily? (page 649)
- Does the mongo shell support tab completion and other keyboard shortcuts? (page 650)
- How can I customize the mongo shell prompt? (page 650)
- Can I edit long shell operations with an external text editor? (page 651)

54.1 How can I enter multi-line operations in the mongo shell?

If you end a line with an open parenthesis (`'('`), an open brace (`'{'`), or an open bracket (`'['`), then the subsequent lines start with ellipsis (`"..."`) until the you enter the corresponding closing parenthesis (`')'`), the closing brace (`'}'`) or the closing bracket (`']'`). The mongo (page 908) shell waits for the closing parenthesis, closing brace, or the closing bracket before evaluating the code, as in the following example:

```
> if ( x > 0 ) {
... count++;
... print (x);
... }
```

You can exit the line continuation mode if you enter two blank lines, as in the following example:

```
> if (x > 0
...
...
>
```

54.2 How can I access to different databases temporarily?

You can use `db.getSiblingDB()` (page 850) method to access another database without switching databases, as in the following example which first switches to the `test` database and then accesses the `sampleDB` database from the `test` database:

```
use test

db.getSiblingDB('sampleDB').getCollectionNames();
```

54.3 Does the mongo shell support tab completion and other keyboard shortcuts?

The mongo (page 908) shell supports keyboard shortcuts. For example,

- Use the up/down arrow keys to scroll through command history. See *.dbshell* (page 909) documentation for more information on the `.dbshell` file.
- Use `<Tab>` to autocomplete or to list the completion possibilities, as in the following example which uses `<Tab>` to complete the method name starting with the letter `'c'`:

  ```
  db.myCollection.c<Tab>
  ```

  Because there are many collection methods starting with the letter `'c'`, the `<Tab>` will list the various methods that start with `'c'`.

For a full list of the shortcuts, see *Shell Keyboard Shortcuts* (page 910)

54.4 How can I customize the mongo shell prompt?

New in version 1.9. You can change the mongo (page 908) shell prompt by setting the `prompt` variable. This makes it possible to display additional information in the prompt.

Set `prompt` to any string or arbitrary JavaScript code that returns a string, consider the following examples:

- Set the shell prompt to display the hostname and the database issued:

  ```
  var host = db.serverStatus().host;
  var prompt = function() { return db+"@"+host+"> "; }
  ```

  The mongo (page 908) shell prompt should now reflect the new prompt:

  ```
  test@my-machine.local>
  ```

- Set the shell prompt to display the database statistics:

  ```
  var prompt = function() {
                  return "Uptime:"+db.serverStatus().uptime+" Documents:"+db.stats().objects+" > "
               }
  ```

  The mongo (page 908) shell prompt should now reflect the new prompt:

  ```
  Uptime:1052 Documents:25024787 >
  ```

You can add the logic for the prompt in the *.mongorc.js* (page 910) file to set the prompt each time you start up the mongo (page 908) shell.

54.5 Can I edit long shell operations with an external text editor?

You can use your own editor in the mongo (page 908) shell by setting the EDITOR (page 910) environment variable before starting the mongo (page 908) shell. Once in the mongo (page 908) shell, you can edit with the specified editor by typing edit <variable> or edit <function>, as in the following example:

1. Set the EDITOR (page 910) variable from the command line prompt:

   ```
   EDITOR=vim
   ```

2. Start the mongo (page 908) shell:

   ```
   mongo
   ```

3. Define a function myFunction:

   ```
   function myFunction () { }
   ```

4. Edit the function using your editor:

   ```
   edit myFunction
   ```

   The command should open the vim edit session. Remember to save your changes.

5. Type myFunction to see the function definition:

   ```
   myFunction
   ```

   The result should be the changes from your saved edit:

   ```
   function myFunction() {
       print("This was edited");
   }
   ```

CHAPTER 55

FAQ: Concurrency

Changed in version 2.2. MongoDB allows multiple clients to read and write a single corpus of data using a locking system to ensure that all clients receive a consistent view of the data *and* to prevent multiple applications from modifying the exact same pieces of data at the same time. Locks help guarantee that all writes to a single document occur either in full or not at all.

Frequently Asked Questions:

- What type of locking does MongoDB use? (page 653)
- How granular are locks in MongoDB? (page 654)
- How do I see the status of locks on my `mongod` (page 897) instances? (page 654)
- Does a read or write operation ever yield the lock? (page 654)
- Which operations lock the database? (page 654)
- Which administrative commands lock the database? (page 655)
- Does a MongoDB operation ever lock more than one database? (page 656)
- How does sharding affect concurrency? (page 656)
- How does concurrency affect a replica set primary? (page 656)
- How does concurrency affect secondaries? (page 656)
- What kind of concurrency does MongoDB provide for JavaScript operations? (page 656)

See Also:

Presentation on Concurrency and Internals in 2.2

55.1 What type of locking does MongoDB use?

MongoDB uses a readers-writer [1] lock that allows concurrent reads access to a database but gives exclusive access to a single write operation.

When a read lock exists, many read operations may use this lock. However, when a write lock exists, a single write operation holds the lock exclusively, and no other read *or* write operations may share the lock.

Locks are "writer greedy," which means writes have preference over reads. When both a read and write are waiting for a lock, MongoDB grants the lock to the write.

[1] You may be familiar with a "readers-writer" lock as "multi-reader" or "shared exclusive" lock. See the Wikipedia page on Readers-Writer Locks for more information.

55.2 How granular are locks in MongoDB?

Changed in version 2.2. Beginning with version 2.2, MongoDB implements locks on a per-database basis for most read and write operations. Some global operations, typically short lived operations involving multiple databases, still require a global "instance" wide lock. Before 2.2, there is only one "global" lock per `mongod` (page 897) instance.

For example, if you have six databases and one takes a write lock, the other five are still available for read and write.

55.3 How do I see the status of locks on my `mongod` instances?

For reporting on lock utilization information on locks, use any of the following methods:

- `db.serverStatus()` (page 854),
- `db.currentOp()` (page 846),
- *mongotop* (page 935),
- *mongostat* (page 931), and/or
- the MongoDB Monitoring Service (MMS)

Specifically, the `locks` (page 966) document in the *output of serverStatus* (page 965), or the `locks` (page 1001) field in the *current operation reporting* (page 998) provides insight into the type of locks and amount of lock contention in your `mongod` (page 897) instance.

To terminate an operation, use `db.killOp()` (page 851).

55.4 Does a read or write operation ever yield the lock?

New in version 2.0. A read and write operations will yield their locks if the `mongod` (page 897) receives a *page fault or* fetches data that is unlikely to be in memory. Yielding allows other operations that only need to access documents that are already in memory to complete while `mongod` (page 897) loads documents into memory.

Additionally, write operations that affect multiple documents (i.e. `update()` (page 842) with the `multi` parameter,) will yield periodically to allow read operations during these long write operations. Similarly, long running read locks will yield periodically to ensure that write operations have the opportunity to complete. Changed in version 2.2: The use of yielding expanded greatly in MongoDB 2.2. Including the "yield for page fault." MongoDB tracks the contents of memory and predicts whether data is available before performing a read. If MongoDB predicts that the data is not in memory a read operation yields its lock while MongoDB loads the data to memory. Once data is available in memory, the read will reacquire the lock to complete the operation.

55.5 Which operations lock the database?

Changed in version 2.2. The following table lists common database operations and the types of locks they use:

Operation	Lock Type
Issue a query	Read lock
Get more data from a *cursor*	Read lock
Insert data	Write lock
Remove data	Write lock
Update data	Write lock
Map-reduce	Read lock and write lock, unless operations are specified as non-atomic. Portions of map-reduce jobs can run concurrently.
Create an index	Building an index in the foreground, which is the default, locks the database for extended periods of time.
`db.eval()` (page 846)	Write lock. `db.eval()` (page 846) blocks all other JavaScript processes.
`eval` (page 755)	Write lock. If used with the `nolock` lock option, the `eval` (page 755) option does not take a write lock and cannot write data to the database.
`aggregate()` (page 815)	Read lock

55.6 Which administrative commands lock the database?

Certain administrative commands can exclusively lock the database for extended periods of time. In some deployments, for large databases, you may consider taking the the `mongod` (page 897) instance offline so that clients are not affected. For example, if a `mongod` (page 897) is part of a *replica set*, take the `mongod` (page 897) offline and let other members of the set service load while maintenance is in progress.

The following administrative operations require an exclusive (i.e. write) lock to a the database for extended periods:

- `db.collection.ensureIndex()` (page 819), when issued *without* setting `background` to `true`,
- `reIndex` (page 784),
- `compact` (page 746),
- `db.repairDatabase()` (page 853),
- `db.createCollection()` (page 845), when creating a very large (i.e. many gigabytes) capped collection,
- `db.collection.validate()` (page 844), and
- `db.copyDatabase()` (page 844). This operation may lock all databases. See *Does a MongoDB operation ever lock more than one database?* (page 656).

The `db.collection.group()` (page 828) operation takes a read lock and does not allow any other threads to execute JavaScript while it is running.

The following administrative commands lock the database but only hold the lock for a very short time:

- `db.collection.dropIndex()` (page 818),
- `db.getLastError()` (page 849),
- `db.isMaster()` (page 850),
- `rs.status()` (page 861) (i.e. `replSetGetStatus` (page 788),)
- `db.serverStatus()` (page 854),
- `db.auth()` (page 814), and
- `db.addUser()` (page 814).

55.7 Does a MongoDB operation ever lock more than one database?

The following MongoDB operations lock multiple databases:

- `db.copyDatabase()` (page 844) must lock the entire `mongod` (page 897) instance at once.
- *Journaling*, which is an internal operation, locks all databases for short intervals. All databases share a single journal.
- *User authentication* (page 90) locks the `admin` database as well as the database the user is accessing.
- All writes to a replica set's *primary* lock both the database receiving the writes and the `local` database. The lock for the `local` database allows the `mongod` (page 897) to write to the primary's *oplog*.

55.8 How does sharding affect concurrency?

Sharding improves concurrency by distributing collections over multiple `mongod` (page 897) instances, allowing shard servers (i.e. `mongos` (page 905) processes) to perform any number of operations concurrently to the various downstream `mongod` (page 897) instances.

Each `mongod` (page 897) instance is independent of the others in the shard cluster and uses the MongoDB *readers-writer lock* (page 653)). The operations on one `mongod` (page 897) instance do not block the operations on any others.

55.9 How does concurrency affect a replica set primary?

In *replication*, when MongoDB writes to a collection on the *primary*, MongoDB also writes to the primary's *oplog*, which is a special collection in the `local` database. Therefore, MongoDB must lock both the collection's database and the `local` database. The `mongod` (page 897) must lock both databases at the same time keep both data consistent and ensure that write operations, even with replication, are "all-or-nothing" operations.

55.10 How does concurrency affect secondaries?

In *replication*, MongoDB does not apply writes serially to *secondaries*. Secondaries collect oplog entries in batches and then apply those batches in parallel. Secondaries do not allow reads while applying the write operations, and apply write operations in the order that they appear in the oplog.

MongoDB can apply several writes in parallel on replica set secondaries, in a two phases:

1. During the first *prefer* phase, under a read lock, the `mongod` (page 897) ensures that all documents affected by the operations are in memory. During this phase, other clients may execute queries against this number.
2. A thread pool using write locks applies all write operations in the batch as part of a coordinated write phase.

55.11 What kind of concurrency does MongoDB provide for JavaScript operations?

A single `mongod` (page 897) can only run a *single* JavaScript operation at once. Therefore, operations that rely on JavaScript cannot run concurrently; however, the `mongod` (page 897) can often run other database operations concurrently with the JavaScript execution. This limitation with JavaScript affects the following operations:

- mapReduce (page 775)

  The JavaScript operations within a mapReduce (page 775) job are short lived and yield many times during the operation. Portions of the map-reduce operation take database locks for reading, writing data to a temporary collection and writing the final output of the write operation.

- group (page 769)

  The group (page 769) takes a read lock in addition to blocking all other JavaScript execution.

- db.eval() (page 846)

  Unless you specify the nolock option, db.eval() (page 846) takes a write lock in addition to blocking all JavaScript operations.

- $where (page 720)

  Only a single query that uses the $where (page 720) operation can run at a time.

CHAPTER 56

FAQ: Sharding with MongoDB

This document answers common questions about horizontal scaling using MongoDB's *sharding*.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List.

Frequently Asked Questions:

- Is sharding appropriate for a new deployment? (page 660)
- How does sharding work with replication? (page 660)
- Can I change the shard key after sharding a collection? (page 660)
- What happens to unsharded collections in sharded databases? (page 660)
- How does MongoDB distribute data across shards? (page 660)
- What happens if a client updates a document in a chunk during a migration? (page 661)
- What happens to queries if a shard is inaccessible or slow? (page 661)
- How does MongoDB distribute queries among shards? (page 661)
- How does MongoDB sort queries in sharded environments? (page 661)
- How does MongoDB ensure unique `_id` field values when using a shard key *other* than `_id`? (page 661)
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- Is it safe to remove old files in the `moveChunk` directory? (page 662)
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- What does `writebacklisten` in the log mean? (page 663)
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- What is the process for moving, renaming, or changing the number of config servers? (page 663)
- When do the `mongos` servers detect config server changes? (page 663)
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- What do `moveChunk commit failed` errors mean? (page 665)
- How does draining a shard affect the balancing of uneven chunk distribution? (page 665)

56.1 Is sharding appropriate for a new deployment?

Sometimes.

If your data set fits on a single server, you should begin with an unsharded deployment.

Converting an unsharded database to a *sharded cluster* is easy and seamless, so there is *little advantage* in configuring sharding while your data set is small.

Still, all production deployments should use *replica sets* to provide high availability and disaster recovery.

56.2 How does sharding work with replication?

To use replication with sharding, deploy each *shard* as a *replica set*.

56.3 Can I change the shard key after sharding a collection?

No.

There is no automatic support in MongoDB for changing a shard key after sharding a collection. This reality underscores the important of choosing a good *shard key* (page 365). If you *must* change a shard key after sharding a collection, the best option is to:

- dump all data from MongoDB into an external format.
- drop the original sharded collection.
- configure sharding using a more ideal shard key.
- *pre-split* (page 393) the shard key range to ensure initial even distribution.
- restore the dumped data into MongoDB.

See `shardCollection` (page 794), `sh.shardCollection()` (page 870), *Sharded Cluster Administration* (page 368), the *Shard Key* (page 374) section in the *Sharded Cluster Internals and Behaviors* (page 374) document, *Deploy a Sharded Cluster* (page 383), and SERVER-4000 for more information.

56.4 What happens to unsharded collections in sharded databases?

In the current implementation, all databases in a *sharded cluster* have a "primary *shard*." All unsharded collection within that database will reside on the same shard.

56.5 How does MongoDB distribute data across shards?

Sharding must be specifically enabled on a collection. After enabling sharding on the collection, MongoDB will assign various ranges of collection data to the different shards in the cluster. The cluster automatically corrects imbalances between shards by migrating ranges of data from one shard to another.

56.6 What happens if a client updates a document in a chunk during a migration?

The mongos (page 905) routes the operation to the "old" shard, where it will succeed immediately. Then the *shard* mongod (page 897) instances will replicate the modification to the "new" shard before the *sharded cluster* updates that chunk's "ownership," which effectively finalizes the migration process.

56.7 What happens to queries if a shard is inaccessible or slow?

If a *shard* is inaccessible or unavailable, queries will return with an error.

However, a client may set the partial query bit, which will then return results from all available shards, regardless of whether a given shard is unavailable.

If a shard is responding slowly, mongos (page 905) will merely wait for the shard to return results.

56.8 How does MongoDB distribute queries among shards?

Changed in version 2.0. The exact method for distributing queries to *shards* in a *cluster* depends on the nature of the query and the configuration of the sharded cluster. Consider a sharded collection, using the *shard key* user_id, that has last_login and email attributes:

- For a query that selects one or more values for the user_id key:

  mongos (page 905) determines which shard or shards contains the relevant data, based on the cluster metadata, and directs a query to the required shard or shards, and returns those results to the client.

- For a query that selects user_id and also performs a sort:

  mongos (page 905) can make a straightforward translation of this operation into a number of queries against the relevant shards, ordered by user_id. When the sorted queries return from all shards, the mongos (page 905) merges the sorted results and returns the complete result to the client.

- For queries that select on last_login:

  These queries must run on all shards: mongos (page 905) must parallelize the query over the shards and perform a merge-sort on the email of the documents found.

56.9 How does MongoDB sort queries in sharded environments?

If you call the cursor.sort() (page 813) method on a query in a sharded environment, the mongod (page 897) for each shard will sort its results, and the mongos (page 905) merges each shard's results before returning them to the client.

56.10 How does MongoDB ensure unique _id field values when using a shard key *other* than _id?

If you do not use _id as the shard key, then your application/client layer must be responsible for keeping the _id field unique. It is problematic for collections to have duplicate _id values.

If you're not sharding your collection by the `_id` field, then you should be sure to store a globally unique identifier in that field. The default *BSON ObjectID* (page 142) works well in this case.

56.11 I've enabled sharding and added a second shard, but all the data is still on one server. Why?

First, ensure that you've declared a *shard key* for your collection. Until you have configured the shard key, MongoDB will not create *chunks*, and *sharding* will not occur.

Next, keep in mind that the default chunk size is 64 MB. As a result, in most situations, the collection needs at least 64 MB before a migration will occur.

Additionally, the system which balances chunks among the servers attempts to avoid superfluous migrations. Depending on the number of shards, your shard key, and the amount of data, systems often require at least 10 chunks of data to trigger migrations.

You can run `db.printShardingStatus()` (page 852) to see all the chunks present in your cluster.

56.12 Is it safe to remove old files in the `moveChunk` directory?

Yes. `mongod` (page 897) creates these files as backups during normal *shard* balancing operations.

Once these migrations are complete, you may delete these files.

You can set `noMoveParanoia` (page 954) to `true` to disable this behavior.

56.13 How does `mongos` use connections?

Each client maintains a connection to a `mongos` (page 905) instance. Each `mongos` (page 905) instance maintains a pool of connections to the members of a replica set supporting the sharded cluster. Clients use connections between `mongos` (page 905) and `mongod` (page 897) instances one at a time. Requests are not multiplexed or pipelined. When client requests complete, the `mongos` (page 905) returns the connection to the pool.

See the *System Resource Utilization* (page 71) section of the *Linux ulimit Settings* (page 71) document.

56.14 Why does `mongos` hold connections open?

`mongos` (page 905) uses a set of connection pools to communicate with each *shard*. These pools do not shrink when the number of clients decreases.

This can lead to an unused `mongos` (page 905) with a large number of open connections. If the `mongos` (page 905) is no longer in use, it is safe to restart the process to close existing connections.

56.15 Where does MongoDB report on connections used by `mongos`?

Connect to the `mongos` (page 905) with the `mongo` (page 908) shell, and run the following command:

```
db._adminCommand("connPoolStats");
```

56.16 What does `writebacklisten` in the log mean?

The writeback listener is a process that opens a long poll to relay writes back from a `mongod` (page 897) or `mongos` (page 905) after migrations to make sure they have not gone to the wrong server. The writeback listener sends writes back to the correct server if necessary.

These messages are a key part of the sharding infrastructure and should not cause concern.

56.17 How should administrators deal with failed migrations?

Failed migrations require no administrative intervention. Chunk moves are consistent and deterministic.

If a migration fails to complete for some reason, the *cluster* will retry the operation. When the migration completes successfully, the data will reside only on the new shard.

56.18 What is the process for moving, renaming, or changing the number of config servers?

See Also:

Manage the Config Servers (page 389) which describes this process.

56.19 When do the `mongos` servers detect config server changes?

`mongos` (page 905) instances maintain a cache of the *config database* that holds the metadata for the *sharded cluster*. This metadata includes the mapping of *chunks* to *shards*.

`mongos` (page 905) updates its cache lazily by issuing a request to a shard and discovering that its metadata is out of date. There is no way to control this behavior from the client, but you can run the `flushRouterConfig` (page 763) command against any `mongos` (page 905) to force it to refresh its cache.

56.20 Is it possible to quickly update `mongos` servers after updating a replica set configuration?

The `mongos` (page 905) instances will detect these changes without intervention over time. However, if you want to force the `mongos` (page 905) to reload its configuration, run the `flushRouterConfig` (page 763) command against to each `mongos` (page 905) directly.

56.21 What does the `maxConns` setting on `mongos` do?

The `maxConns` (page 946) option limits the number of connections accepted by `mongos` (page 905).

If your client driver or application creates a large number of connections but allows them to time out rather than closing them explicitly, then it might make sense to limit the number of connections at the `mongos` (page 905) layer.

Set `maxConns` (page 946) to a value slightly higher than the maximum number of connections that the client creates, or the maximum size of the connection pool. This setting prevents the `mongos` (page 905) from causing connection

spikes on the individual *shards*. Spikes like these may disrupt the operation and memory allocation of the *sharded cluster*.

56.22 How do indexes impact queries in sharded systems?

If the query does not include the *shard key*, the `mongos` (page 905) must send the query to all shards as a "scatter/gather" operation. Each shard will, in turn, use *either* the shard key index or another more efficient index to fulfill the query.

If the query includes multiple sub-expressions that reference the fields indexed by the shard key *and* the secondary index, the `mongos` (page 905) can route the queries to a specific shard and the shard will use the index that will allow it to fulfill most efficiently. See this document for more information.

56.23 Can shard keys be randomly generated?

Shard keys can be random. Random keys ensure optimal distribution of data across the cluster.

Sharded clusters, attempt to route queries to *specific* shards when queries include the shard key as a parameter, because these directed queries are more efficient. In many cases, random keys can make it difficult to direct queries to specific shards.

56.24 Can shard keys have a non-uniform distribution of values?

Yes. There is no requirement that documents be evenly distributed by the shard key.

However, documents that have the shard key *must* reside in the same *chunk* and therefore on the same server. If your sharded data set has too many documents with the exact same shard key you will not be able to distribute *those* documents across your sharded cluster.

56.25 Can you shard on the `_id` field?

You can use any field for the shard key. The `_id` field is a common shard key.

Be aware that `ObjectId()` values, which are the default value of the `_id` field, increment as a timestamp. As a result, when used as a shard key, all new documents inserted into the collection will initially belong to the same chunk on a single shard. Although the system will eventually divide this chunk and migrate its contents to distribute data more evenly, at any moment the cluster can only direct insert operations at a single shard. This can limit the throughput of inserts. If most of your write operations are updates or read operations rather than inserts, this limitation should not impact your performance. However, if you have a high insert volume, this may be a limitation.

56.26 Can shard key be in ascending order, like dates or timestamps?

If you insert documents with monotonically increasing shard keys, all inserts will initially belong to the same *chunk* on a single *shard*. Although the system will eventually divide this chunk and migrate its contents to distribute data more evenly, at any moment the cluster can only direct insert operations at a single shard. This can limit the throughput of inserts.

If most of your write operations are updates or read operations rather than inserts, this limitation should not impact your performance. However, if you have a high insert volume, a monotonically increasing shard key may be a limitation.

To address this issue, you can use a field with a value that stores the hash of a key with an ascending value. While you can compute a hashed value in your application and include this value in your documents for use as a shard key, the SERVER-2001 issue will implement this capability within MongoDB.

56.27 What do `moveChunk commit failed` errors mean?

Consider the following error message:

```
ERROR: moveChunk commit failed: version is at <n>|<nn> instead of <N>|<NN>" and "ERROR: TERMINATING"
```

`mongod` (page 897) issues this message if, during a *chunk migration* (page 380), the *shard* could not connect to the *config database* to update chunk information at the end of the migration process. If the shard cannot update the config database after `moveChunk` (page 782), the cluster will have an inconsistent view of all chunks. In these situations, the *primary* member of the shard will terminate itself to prevent data inconsistency. If the *secondary* member can access the config database, the shard's data will be accessible after an election. Administrators will need to resolve the chunk migration failure independently.

If you encounter this issue, contact the MongoDB User Group or 10gen support to address this issue.

56.28 How does draining a shard affect the balancing of uneven chunk distribution?

The sharded cluster balancing process controls both migrating chunks from decommissioned shards (i.e. draining,) and normal cluster balancing activities. Consider the following behaviors for different versions of MongoDB in situations where you remove a shard in a cluster with an uneven chunk distribution:

- After MongoDB 2.2, the balancer first removes the chunks from the draining shard and then balances the remaining uneven chunk distribution.
- Before MongoDB 2.2, the balancer handles the uneven chunk distribution and *then* removes the chunks from the draining shard.

CHAPTER 57

FAQ: Replica Sets and Replication in MongoDB

This document answers common questions about database replication in MongoDB.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List.

Frequently Asked Questions:

- What kinds of replication does MongoDB support? (page 667)
- What do the terms "primary" and "master" mean? (page 668)
- What do the terms "secondary" and "slave" mean? (page 668)
- How long does replica set failover take? (page 668)
- Does replication work over the Internet and WAN connections? (page 668)
- Can MongoDB replicate over a "noisy" connection? (page 668)
- What is the preferred replication method: master/slave or replica sets? (page 669)
- What is the preferred replication method: replica sets or replica pairs? (page 669)
- Why use journaling if replication already provides data redundancy? (page 669)
- Are write operations durable if write concern does not acknowledge writes? (page 669)
- How many arbiters do replica sets need? (page 670)
- What information do arbiters exchange with the rest of the replica set? (page 670)
- Which members of a replica set vote in elections? (page 670)
- Do hidden members vote in replica set elections? (page 671)
- Is it normal for replica set members to use different amounts of disk space? (page 671)

57.1 What kinds of replication does MongoDB support?

MongoDB supports master-slave replication and a variation on master-slave replication known as replica sets. Replica sets are the recommended replication topology.

57.2 What do the terms "primary" and "master" mean?

Primary and *master* nodes are the nodes that can accept writes. MongoDB's replication is "single-master:" only one node can accept write operations at a time.

In a replica set, if a the current "primary" node fails or becomes inaccessible, the other members can autonomously *elect* one of the other members of the set to be the new "primary".

By default, clients send all reads to the primary; however, *read preference* is configurable at the client level on a per-connection basis, which makes it possible to send reads to secondary nodes instead.

57.3 What do the terms "secondary" and "slave" mean?

Secondary and *slave* nodes are read-only nodes that replicate from the *primary*.

Replication operates by way of an *oplog*, from which secondary/slave members apply new operations to themselves. This replication process is asynchronous, so secondary/slave nodes may not always reflect the latest writes to the primary. But usually, the gap between the primary and secondary nodes is just few milliseconds on a local network connection.

57.4 How long does replica set failover take?

It varies, but a replica set will select a new primary within a minute.

It may take 10-30 seconds for the members of a *replica set* to declare a *primary* inaccessible. This triggers an *election*. During the election, the cluster is unavailable for writes.

The election itself may take another 10-30 seconds.

Note: *Eventually consistent* reads, like the ones that will return from a replica set are only possible with a *write concern* that permits reads from *secondary* members.

57.5 Does replication work over the Internet and WAN connections?

Yes.

For example, a deployment may maintain a *primary* and *secondary* in an East-coast data center along with a *secondary* member for disaster recovery in a West-coast data center.

See Also:

Deploy a Geographically Distributed Replica Set (page 330)

57.6 Can MongoDB replicate over a "noisy" connection?

Yes, but not without connection failures and the obvious latency.

Members of the set will attempt to reconnect to the other members of the set in response to networking flaps. This does not require administrator intervention. However, if the network connections between the nodes in the replica set are very slow, it might not be possible for the members of the node to keep up with the replication.

If the TCP connection between the secondaries and the *primary* instance breaks, a *replica set* the set will automatically elect one of the *secondary* members of the set as primary.

57.7 What is the preferred replication method: master/slave or replica sets?

New in version 1.8. *Replica sets* are the preferred *replication* mechanism in MongoDB. However, if your deployment requires more than 12 nodes, you must use master/slave replication.

57.8 What is the preferred replication method: replica sets or replica pairs?

Deprecated since version 1.6. *Replica sets* replaced *replica pairs* in version 1.6. *Replica sets* are the preferred *replication* mechanism in MongoDB.

57.9 Why use journaling if replication already provides data redundancy?

Journaling facilitates faster crash recovery. Prior to journaling, crashes often required `database repairs` (page 787) or full data resync. Both were slow, and the first was unreliable.

Journaling is particularly useful for protection against power failures, especially if your replica set resides in a single data center or power circuit.

When a *replica set* runs with journaling, `mongod` (page 897) instances can safely restart without any administrator intervention.

Note: Journaling requires some resource overhead for write operations. Journaling has no effect on read performance, however.

Journaling is enabled by default on all 64-bit builds of MongoDB v2.0 and greater.

57.10 Are write operations durable if write concern does not acknowledge writes?

Yes.

However, if you want confirmation that a given write has arrived at the server, use *write concern* (page 124). The `getLastError` (page 766) command provides the facility for write concern. However, after the *default write concern change* (page 1061), the default write concern acknowledges all write operations, and unacknowledged writes must be explicitly configured. See the *MongoDB Drivers and Client Libraries* (page 435) documentation for your driver for more information.

57.11 How many arbiters do replica sets need?

Some configurations do not require any *arbiter* instances. Arbiters vote in *elections* for *primary* but do not replicate the data like *secondary* members.

Replica sets require a majority of the original nodes present to elect a primary. Arbiters allow you to construct this majority without the overhead of adding replicating nodes to the system.

There are many possible replica set *architectures* (page 300).

If you have a three node replica set, you don't need an arbiter.

But a common configuration consists of two replicating nodes, one of which is *primary* and the other is *secondary*, as well as an arbiter for the third node. This configuration makes it possible for the set to elect a primary in the event of a failure without requiring three replicating nodes.

You may also consider adding an arbiter to a set if it has an equal number of nodes in two facilities and network partitions between the facilities are possible. In these cases, the arbiter will break the tie between the two facilities and allow the set to elect a new primary.

See Also:

Replica Set Architectures and Deployment Patterns (page 300)

57.12 What information do arbiters exchange with the rest of the replica set?

Arbiters never receive the contents of a collection but do exchange the following data with the rest of the replica set:

- Credentials used to authenticate the arbiter with the replica set. All MongoDB processes within a replica set use keyfiles. These exchanges are encrypted.
- Replica set configuration data and voting data. This information is not encrypted. Only credential exchanges are encrypted.

If your MongoDB deployment uses SSL, then all communications between arbiters and the other members of the replica set are secure. See the documentation for *Use MongoDB with SSL Connections* (page 47) for more information. Run all arbiters on secure networks, as with all MongoDB components.

See Also:

The overview of *Arbiter Members of Replica Sets* (page 288).

57.13 Which members of a replica set vote in elections?

All members of a replica set, unless the value of `votes` is equal to `0`, vote in elections. This includes all *delayed* (page 287), *hidden* (page 287) and *secondary-only* (page 286) members, as well as the *arbiters* (page 288).

See Also:

Elections (page 280)

57.14 Do hidden members vote in replica set elections?

Hidden members (page 287) of term:*replica :sets do* vote in elections. To exclude a member from voting in an :election, change the value of the member's `votes` (page 991) configuration to `0`.

See Also:

Elections (page 280)

57.15 Is it normal for replica set members to use different amounts of disk space?

Yes.

Factors including: different oplog sizes, different levels of storage fragmentation, and MongoDB's data file preallocation can lead to some variation in storage utilization between nodes. Storage use disparities will be most pronounced when you add members at different times.

CHAPTER 58

FAQ: MongoDB Storage

This document addresses common questions regarding MongoDB's storage system.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List.

Frequently Asked Questions:

- What are memory mapped files? (page 673)
- How do memory mapped files work? (page 673)
- How does MongoDB work with memory mapped files? (page 674)
- What are page faults? (page 674)
- What is the difference between soft and hard page faults? (page 674)
- What tools can I use to investigate storage use in MongoDB? (page 674)
- What is the working set? (page 674)
- Why are the files in my data directory larger than the data in my database? (page 675)
- How can I check the size of a collection? (page 676)
- How can I check the size of indexes? (page 676)
- How do I know when the server runs out of disk space? (page 676)

58.1 What are memory mapped files?

A memory-mapped file is a file with data that the operating system places in memory by way of the `mmap()` system call. `mmap()` thus *maps* the file to a region of virtual memory. Memory-mapped files are the critical piece of the storage engine in MongoDB. By using memory mapped files MongoDB can treat the content of its data files as if they were in memory. This provides MongoDB with an extremely fast and simple method for accessing and manipulating data.

58.2 How do memory mapped files work?

Memory mapping assigns files to a block of virtual memory with a direct byte-for-byte correlation. Once mapped, the relationship between file and memory allows MongoDB to interact with the data in the file as if it were memory.

58.3 How does MongoDB work with memory mapped files?

MongoDB uses memory mapped files for managing and interacting with all data. MongoDB memory maps data files to memory as it accesses documents. Data that isn't accessed is *not* mapped to memory.

58.4 What are page faults?

Page faults will occur if you're attempting to access part of a memory-mapped file that *isn't* in memory.

If there is free memory, then the operating system can find the page on disk and load it to memory directly. However, if there is no free memory, the operating system must:

- find a page in memory that is stale or no longer needed, and write the page to disk.
- read the requested page from disk and load it into memory.

This process, particularly on an active system can take a long time, particularly in comparison to reading a page that is already in memory.

58.5 What is the difference between soft and hard page faults?

Page faults occur when MongoDB needs access to data that isn't currently in active memory. A "hard" page fault refers to situations when MongoDB must access a disk to access the data. A "soft" page fault, by contrast, merely moves memory pages from one list to another, such as from an operating system file cache. In production, MongoDB will rarely encounter soft page faults.

58.6 What tools can I use to investigate storage use in MongoDB?

The `db.stats()` (page 855) method in the `mongo` (page 908) shell, returns the current state of the "active" database. The *Database Statistics Reference* (page 979) document outlines the meaning of the fields in the `db.stats()` (page 855) output.

58.7 What is the working set?

Working set represents the total body of data that the application uses in the course of normal operation. Often this is a subset of the total data size, but the specific size of the working set depends on actual moment-to-moment use of the database.

If you run a query that requires MongoDB to scan every document in a collection, the working set will expand to include every document. Depending on physical memory size, this may cause documents in the working set to "page out," or removed from physical memory by the operating system. The next time MongoDB needs to access these documents, MongoDB may incur a hard page fault.

If you run a query that requires MongoDB to scan every *document* in a collection, the working set includes every active document in memory.

For best performance, the majority of your *active* set should fit in RAM.

58.8 Why are the files in my data directory larger than the data in my database?

The data files in your data directory, which is the `http://docs.mongodb.org/v2.2/data/db` directory in default configurations, might be larger than the data set inserted into the database. Consider the following possible causes:

- Preallocated data files.

  In the data directory, MongoDB preallocates data files to a particular size, in part to prevent file system fragmentation. MongoDB names first data file `<databasename>.0`, the next `<databasename>.1`, etc. The first file `mongod` (page 897) allocates is 64 megabytes, the next 128 megabytes, and so on, up to 2 gigabytes, at which point all subsequent files are 2 gigabytes. The data files include files with allocated space but that hold no data. `mongod` (page 897) may allocate a 1 gigabyte data file that may be 90% empty. For most larger databases, unused allocated space is small compared to the database.

  On Unix-like systems, `mongod` (page 897) preallocates an additional data file and initializes the disk space to `0`. Preallocating data files in the background prevents significant delays when a new database file is next allocated.

  You can disable preallocation with `noprealloc` (page 949) run time option. However `noprealloc` (page 949) is **not** intended for use in production environments: only use `noprealloc` (page 949) for testing and with small data sets where you frequently drop databases.

  On Linux systems you can use `hdparm` to get an idea of how costly allocation might be:

  ```
  time hdparm --fallocate $((1024*1024)) testfile
  ```

- The *oplog*.

  If this `mongod` (page 897) is a member of a replica set, the data directory includes the *oplog.rs* file, which is a preallocated *capped collection* in the `local` database. The default allocation is approximately 5% of disk space on a 64-bit installations, see *Oplog Sizing* (page 282) for more information. In most cases, you should not need to resize the oplog. However, if you do, see *Change the Size of the Oplog* (page 336).

- The *journal*.

  The data directory contains the journal files, which store write operations on disk prior to MongoDB applying them to databases. See *Journaling* (page 41).

- Empty records.

  MongoDB maintains lists of empty records in data files when deleting documents and collections. MongoDB can reuse this space, but will never return this space to the operating system.

  To reclaim deleted space, use either of the following:

  - `compact` (page 746), which defragments deleted space. `compact` (page 746) requires up to 2 gigabytes of extra disk space to run. Do not use `compact` (page 746) if you are critically low on disk space.
  - `repairDatabase` (page 787), which rebuilds the database. Both options require additional disk space to run. For details, see *Recover MongoDB Data following Unexpected Shutdown* (page 596).

    Warning: `repairDatabase` (page 787) requires enough free disk space to hold both the old and new database files while the repair is running. Be aware that `repairDatabase` (page 787) will block all other operations and may take a long time to complete.

58.9 How can I check the size of a collection?

To view the size of a collection and other information, use the `stats()` (page 841) method from the `mongo` (page 908) shell. The following example issues `stats()` (page 841) for the `orders` collection:

```
db.orders.stats();
```

To view specific measures of size, use these methods:

- `db.collection.dataSize()` (page 817): data size for the collection.
- `db.collection.storageSize()` (page 841): allocation size, including unused space.
- `db.collection.totalSize()` (page 842): the data size plus the index size.
- `db.collection.totalIndexSize()` (page 842): the index size.

Also, the following scripts print the statistics for each database and collection:

```
db._adminCommand("listDatabases").databases.forEach(function (d) {mdb = db.getSiblingDB(d.name); prin
```

```
db._adminCommand("listDatabases").databases.forEach(function (d) {mdb = db.getSiblingDB(d.name); mdb
```

58.10 How can I check the size of indexes?

To view the size of the data allocated for an index, use one of the following procedures in the `mongo` (page 908) shell:

- Use the `stats()` (page 841) method using the index namespace. To retrieve a list of namespaces, issue the following command:

  ```
  db.system.namespaces.find()
  ```

- Check the value of `indexSizes` (page 982) value in the output of `db.collection.stats()` (page 841) command.

Example

Issue the following command to retrieve index namespaces:

```
db.system.namespaces.find()
```

The command returns a list similar to the following:

```
{"name" : "test.orders"}
{"name" : "test.system.indexes"}
{"name" : "test.orders.$_id_"}
```

View the size of the data allocated for the `orders.$_id_` index with the following sequence of operations:

```
use test
db.orders.$_id_.stats().indexSizes
```

58.11 How do I know when the server runs out of disk space?

If your server runs out of disk space for data files, you will see something like this in the log:

```
Thu Aug 11 13:06:09 [FileAllocator] allocating new data file dbms/test.13, filling with zeroes...
Thu Aug 11 13:06:09 [FileAllocator] error failed to allocate new file: dbms/test.13 size: 2146435072
Thu Aug 11 13:06:09 [FileAllocator]     will try again in 10 seconds
Thu Aug 11 13:06:19 [FileAllocator] allocating new data file dbms/test.13, filling with zeroes...
Thu Aug 11 13:06:19 [FileAllocator] error failed to allocate new file: dbms/test.13 size: 2146435072
Thu Aug 11 13:06:19 [FileAllocator]     will try again in 10 seconds
```

The server remains in this state forever, blocking all writes including deletes. However, reads still work. To delete some data and compact, using the `compact` (page 746) command, you must restart the server first.

If your server runs out of disk space for journal files, the server process will exit. By default, `mongod` (page 897) creates journal files in a sub-directory of `dbpath` (page 947) named `journal`. You may elect to put the journal files on another storage device using a filesystem mount or a symlink.

Note: If you place the journal files on a separate storage device you will not be able to use a file system snapshot tool to capture a consistent snapshot of your data files and journal files.

CHAPTER 59

FAQ: Indexes

This document addresses common questions regarding MongoDB indexes.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List. See also *Indexing Strategies* (page 257).

Frequently Asked Questions:

- Should you run `ensureIndex()` after every insert? (page 679)
- How do you know what indexes exist in a collection? (page 680)
- How do you determine the size of an index? (page 680)
- What happens if an index does not fit into RAM? (page 680)
- How do you know what index a query used? (page 680)
- How do you determine what fields to index? (page 680)
- How do write operations affect indexes? (page 680)
- Will building a large index affect database performance? (page 680)
- Can I use index keys to constrain query matches? (page 681)
- Using `$ne` and `$nin` in a query is slow. Why? (page 681)
- Can I use a multi-key index to support a query for a whole array? (page 681)
- How can I effectively use indexes strategy for attribute lookups? (page 681)

59.1 Should you run `ensureIndex()` after every insert?

No. You only need to create an index once for a single collection. After initial creation, MongoDB automatically updates the index as data changes.

While running `ensureIndex()` (page 819) is usually ok, if an index doesn't exist because of ongoing administrative work, a call to `ensureIndex()` (page 819) may disrupt database availability. Running `ensureIndex()` (page 819) can render a replica set inaccessible as the index creation is happening. See *Build Indexes on Replica Sets* (page 255).

59.2 How do you know what indexes exist in a collection?

To list a collection's indexes, use the `db.collection.getIndexes()` (page 826) method or a similar method for your driver.

59.3 How do you determine the size of an index?

To check the sizes of the indexes on a collection, use `db.collection.stats()` (page 841).

59.4 What happens if an index does not fit into RAM?

When an index is too large to fit into RAM, MongoDB must read the index from disk, which is a much slower operation than reading from RAM. Keep in mind an index fits into RAM when your server has RAM available for the index combined with the rest of the *working set*.

In certain cases, an index does not need to fit *entirely* into RAM. For details, see *Indexes that Hold Only Recent Values in RAM* (page 260).

59.5 How do you know what index a query used?

To inspect how MongoDB processes a query, use the `explain()` (page 805) method in the `mongo` (page 908) shell, or in your application driver.

59.6 How do you determine what fields to index?

A number of factors determine what fields to index, including *selectivity* (page 261), fitting indexes into RAM, reusing indexes in multiple queries when possible, and creating indexes that can support all the fields in a given query. For detailed documentation on choosing which fields to index, see *Indexing Strategies* (page 257).

59.7 How do write operations affect indexes?

Any write operation that alters an indexed field requires an update to the index in addition to the document itself. If you update a document that causes the document to grow beyond the allotted record size, then MongoDB must update all indexes that include this document as part of the update operation.

Therefore, if your application is write-heavy, creating too many indexes might affect performance.

59.8 Will building a large index affect database performance?

Building an index can be an IO-intensive operation, especially if you have a large collection. This is true on any database system that supports secondary indexes, including MySQL. If you need to build an index on a large collection, consider building the index in the background. See *Index Creation Options* (page 247).

If you build a large index without the background option, and if doing so causes the database to stop responding, wait for the index to finish building.

59.9 Can I use index keys to constrain query matches?

You can use the `min()` (page 809) and `max()` (page 807) methods to constrain the results of the cursor returned from `find()` (page 820) by using index keys.

59.10 Using `$ne` and `$nin` in a query is slow. Why?

The `$ne` (page 704) and `$nin` (page 705) operators are not selective. See *Create Queries that Ensure Selectivity* (page 261). If you need to use these, it is often best to make sure that an additional, more selective criterion is part of the query.

59.11 Can I use a multi-key index to support a query for a whole array?

Not entirely. The index can partially support these queries because it can speed the selection of the first element of the array; however, comparing all subsequent items in the array cannot use the index and must scan the documents individually.

59.12 How can I effectively use indexes strategy for attribute lookups?

For simple attribute lookups that don't require sorted result sets or range queries, consider creating a field that contains an array of documents where each document has a field (e.g. `attrib`) that holds a specific type of attribute. You can index this `attrib` field.

For example, the `attrib` field in the following document allows you to add an unlimited number of attributes types:

```
{ _id : ObjectId(...),
  attrib : [
             { k: "color", v: "red" },
             { k: "shape": v: "rectangle" },
             { k: "color": v: "blue" },
             { k: "avail": v: true }
           ]
}
```

Both of the following queries could use the same `{ "attrib.k": 1, "attrib.v": 1 }` index:

```
db.mycollection.find( { attrib: { $elemMatch : { k: "color", v: "blue" } } } )
db.mycollection.find( { attrib: { $elemMatch : { k: "avail", v: true } } } )
```

CHAPTER 60

FAQ: MongoDB Diagnostics

This document provides answers to common diagnostic questions and issues.

If you don't find the answer you're looking for, check the *complete list of FAQs* (page 635) or post your question to the MongoDB User Mailing List.

Frequently Asked Questions:

- Where can I find information about a `mongod` process that stopped running unexpectedly? (page 683)
- Does TCP `keepalive` time affect sharded clusters and replica sets? (page 684)
- Memory Diagnostics (page 684)
  - Do I need to configure swap space? (page 684)
  - Must my working set size fit RAM? (page 684)
  - How do I calculate how much RAM I need for my application? (page 685)
  - How do I read memory statistics in the UNIX `top` command (page 685)
- Sharded Cluster Diagnostics (page 685)
  - In a new sharded cluster, why does all data remains on one shard? (page 686)
  - Why would one shard receive a disproportion amount of traffic in a sharded cluster? (page 686)
  - What can prevent a sharded cluster from balancing? (page 686)
  - Why do chunk migrations affect sharded cluster performance? (page 687)

60.1 Where can I find information about a `mongod` process that stopped running unexpectedly?

If `mongod` (page 897) shuts down unexpectedly on a UNIX or UNIX-based platform, and if `mongod` (page 897) fails to log a shutdown or error message, then check your system logs for messages pertaining to MongoDB. For example, for logs located in in `http://docs.mongodb.org/v2.2/var/log/messages`, use the the following commands:

```
sudo grep mongod /var/log/messages
sudo grep score /var/log/messages
```

60.2 Does TCP keepalive time affect sharded clusters and replica sets?

If you experience socket errors between members of a sharded cluster or replica set, that do not have other reasonable causes, check the TCP keep alive value, which Linux systems store as the `tcp_keepalive_time` value. A common keep alive period is `7200` seconds (2 hours); however, different distributions and OS X may have different settings. For MongoDB, you will have better experiences with shorter keepalive periods, on the order of `300` seconds (five minutes).

On Linux systems you can use the following operation to check the value of `tcp_keepalive_time`:

```
cat /proc/sys/net/ipv4/tcp_keepalive_time
```

You can change the `tcp_keepalive_time` value with the following operation:

```
echo 300 > /proc/sys/net/ipv4/tcp_keepalive_time
```

The new `tcp_keepalive_time` value takes effect without requiring you to restart the `mongod` (page 897) or `mongos` (page 905) servers. When you reboot or restart your system you will need to set the new `tcp_keepalive_time` value, or see your operating system's documentation for setting the TCP keepalive value persistently.

For OS X systems, issue the following command to view the keep alive setting:

```
sysctl net.inet.tcp.keepinit
```

To set a shorter keep alive period use the following invocation:

```
sysctl -w net.inet.tcp.keepinit=300
```

If your replica set or sharded cluster experiences keepalive-related issues, you must must alter the `tcp_keepalive_time` value on all machines hosting MongoDB processes. This includes all machines hosting `mongos` (page 905) or `mongod` (page 897) servers.

60.3 Memory Diagnostics

60.3.1 Do I need to configure swap space?

Always configure systems to have swap space. Without swap, your system may not be reliant in some situations with extreme memory constrains, memory leaks, or multiple programs using the same memory. Think of the swap space as something like a steam release valve that allows the system to release extra pressure without affecting the overall functioning of the system.

Nevertheless, systems running MongoDB *do not* need swap for routine operation. Database files are *memory-mapped* (page 673) and should constitute most of your MongoDB memory use. Therefore, it is unlikely that `mongod` (page 897) will ever use any swap space in normal operation. The operating system will release memory from the memory mapped files without needing swap and MongoDB can write data to the data files without needing the swap system.

60.3.2 Must my working set size fit RAM?

Your working set should stay in memory to achieve good performance. Otherwise many random disk IO's will occur, and unless you are using SSD, this can be quite slow.

One area to watch specifically in managing the size of your working set is index access patterns. If you are inserting into indexes at random locations (as would happen with id's that are randomly generated by hashes), you will continually be updating the whole index. If instead you are able to create your id's in approximately ascending order (for example, day concatenated with a random id), all the updates will occur at the right side of the b-tree and the working set size for index pages will be much smaller.

It is fine if databases and thus virtual size are much larger than RAM.

60.3.3 How do I calculate how much RAM I need for my application?

The amount of RAM you need depends on several factors, including but not limited to:

- The relationship between *database storage* (page 673) and working set.
- The operating system's cache strategy for LRU (Least Recently Used)
- The impact of *journaling* (page 41)
- The number or rate of page faults and other MMS gauges to detect when you need more RAM

MongoDB defers to the operating system when loading data into memory from disk. It simply *memory maps* (page 673) all its data files and relies on the operating system to cache data. The OS typically evicts the least-recently-used data from RAM when it runs low on memory. For example if clients access indexes more frequently than documents, then indexes will more likely stay in RAM, but it depends on your particular usage.

To calculate how much RAM you need, you must calculate your working set size, or the portion of your data that clients use most often. This depends on your access patterns, what indexes you have, and the size of your documents.

If page faults are infrequent, your working set fits in RAM. If fault rates rise higher than that, you risk performance degradation. This is less critical with SSD drives than with spinning disks.

60.3.4 How do I read memory statistics in the UNIX `top` command

Because `mongod` (page 897) uses *memory-mapped files* (page 673), the memory statistics in `top` require interpretation in a special way. On a large database, `VSIZE` (virtual bytes) tends to be the size of the entire database. If the `mongod` (page 897) doesn't have other processes running, `RSIZE` (resident bytes) is the total memory of the machine, as this counts file system cache contents.

For Linux systems, use the `vmstat` command to help determine how the system uses memory. On OS X systems use `vm_stat`.

60.4 Sharded Cluster Diagnostics

The two most important factors in maintaining a successful sharded cluster are:

- *choosing an appropriate shard key* (page 374) and
- *sufficient capacity to support current and future operations* (page 367).

You can prevent most issues encountered with sharding by ensuring that you choose the best possible *shard key* for your deployment and ensure that you are always adding additional capacity to your cluster well before the current resources become saturated. Continue reading for specific issues you may encounter in a production environment.

60.4.1 In a new sharded cluster, why does all data remains on one shard?

Your cluster must have sufficient data for sharding to make sense. Sharding works by migrating chunks between the shards until each shard has roughly the same number of chunks.

The default chunk size is 64 megabytes. MongoDB will not begin migrations until the imbalance of chunks in the cluster exceeds the *migration threshold* (page 378). While the default chunk size is configurable with the `chunkSize` (page 954) setting, these behaviors help prevent unnecessary chunk migrations, which can degrade the performance of your cluster as a whole.

If you have just deployed a sharded cluster, make sure that you have enough data to make sharding effective. If you do not have sufficient data to create more than eight 64 megabyte chunks, then all data will remain on one shard. Either lower the *chunk size* (page 379) setting, or add more data to the cluster.

As a related problem, the system will split chunks only on inserts or updates, which means that if you configure sharding and do not continue to issue insert and update operations, the database will not create any chunks. You can either wait until your application inserts data *or* *split chunks manually* (page 392).

Finally, if your shard key has a low *cardinality* (page 375), MongoDB may not be able to create sufficient splits among the data.

60.4.2 Why would one shard receive a disproportion amount of traffic in a sharded cluster?

In some situations, a single shard or a subset of the cluster will receive a disproportionate portion of the traffic and workload. In almost all cases this is the result of a shard key that does not effectively allow *write scaling* (page 375).

It's also possible that you have "hot chunks." In this case, you may be able to solve the problem by splitting and then migrating parts of these chunks.

In the worst case, you may have to consider re-sharding your data and *choosing a different shard key* (page 377) to correct this pattern.

60.4.3 What can prevent a sharded cluster from balancing?

If you have just deployed your sharded cluster, you may want to consider the *troubleshooting suggestions for a new cluster where data remains on a single shard* (page 686).

If the cluster was initially balanced, but later developed an uneven distribution of data, consider the following possible causes:

- You have deleted or removed a significant amount of data from the cluster. If you have added additional data, it may have a different distribution with regards to its shard key.
- Your *shard key* has low *cardinality* (page 375) and MongoDB cannot split the chunks any further.
- Your data set is growing faster than the balancer can distribute data around the cluster. This is uncommon and typically is the result of:
  - a *balancing window* (page 399) that is too short, given the rate of data growth.
  - an uneven distribution of *write operations* (page 375) that requires more data migration. You may have to choose a different shard key to resolve this issue.
  - poor network connectivity between shards, which may lead to chunk migrations that take too long to complete. Investigate your network configuration and interconnections between shards.

60.4.4 Why do chunk migrations affect sharded cluster performance?

If migrations impact your cluster or application's performance, consider the following options, depending on the nature of the impact:

1. If migrations only interrupt your clusters sporadically, you can limit the *balancing window* (page 399) to prevent balancing activity during peak hours. Ensure that there is enough time remaining to keep the data from becoming out of balance again.
2. If the balancer is always migrating chunks to the detriment of overall cluster performance:
   - You may want to attempt *decreasing the chunk size* (page 394) to limit the size of the migration.
   - Your cluster may be over capacity, and you may want to attempt to *add one or two shards* (page 387) to the cluster to distribute load.

It's also possible that your shard key causes your application to direct all writes to a single shard. This kind of activity pattern can require the balancer to migrate most data soon after writing it. Consider redeploying your cluster with a shard key that provides better *write scaling* (page 375).

Part XIV

Reference

CHAPTER 61

MongoDB Interface

61.1 Reference

61.1.1 Query, Update, Projection, and Aggregation Operators

- Query and update operators:

$addToSet

$addToSet

The `$addToSet` (page 691) operator adds a value to an array only *if* the value is *not* in the array already. If the value *is* in the array, `$addToSet` (page 691) returns without modifying the array. Consider the following example:

```
db.collection.update( { field: value }, { $addToSet: { field: value1 } } );
```

Here, `$addToSet` (page 691) appends `value1` to the array stored in `field`, *only if* `value1` is not already a member of this array.

Note: `$addToSet` (page 691) only ensures that there are no duplicate items in a set and makes no guarantees regarding the order of the elements in the set.

See Also:

`$each` (page 695) and `$push` (page 711)

$all

$all

Syntax: `{ field: { $all: [ <value> , <value1> ... ] } }`

`$all` (page 691) selects the documents where the `field` holds an array and contains all elements (e.g. `<value>`, `<value1>`, etc.) in the array.

Consider the following example:

```
db.inventory.find( { tags: { $all: [ "appliances", "school", "book" ] } } )
```

This query selects all documents in the `inventory` collection where the `tags` field contains an array with the elements, `appliances`, `school`, and `book`.

Therefore, the above query will match documents in the `inventory` collection that have a `tags` field that hold *either* of the following arrays:

```
[ "school", "book", "bag", "headphone", "appliances" ]
[ "appliances", "school", "book" ]
```

The `$all` (page 691) operator exists to describe and specify arrays in MongoDB queries. However, you may use the `$all` (page 691) operator to select against a non-array `field`, as in the following example:

```
db.inventory.find( { qty: { $all: [ 50 ] } } )
```

However, use the following form to express the same query:

```
db.inventory.find( { qty: 50 } )
```

Both queries will select all documents in the `inventory` collection where the value of the `qty` field equals `50`.

Note: In most cases, MongoDB does not treat arrays as sets. This operator provides a notable exception to this approach.

In the current release queries that use the `$all` (page 691) operator must scan all the documents that match the first element in the query array. As a result, even with an index to support the query, the operation may be long running, particularly when the first element in the array is not very selective.

See Also:

`find()` (page 820), `update()` (page 842), and `$set` (page 716).

$and

$and

New in version 2.0. *Syntax*: `{ $and: [ { <expression1> }, { <expression2> } , ... , { <expressionN> } ] }`

`$and` (page 692) performs a logical `AND` operation on an array of *two or more* expressions (e.g. `<expression1>`, `<expression2>`, etc.) and selects the documents that satisfy *all* the expressions in the array. The `$and` (page 692) operator uses *short-circuit evaluation*. If the first expression (e.g. `<expression1>`) evaluates to `false`, MongoDB will not evaluate the remaining expressions.

Consider the following example:

```
db.inventory.find({ $and: [ { price: 1.99 }, { qty: { $lt: 20 } }, { sale: true } ] } )
```

This query will select all documents in the `inventory` collection where:

- `price` field value equals `1.99` **and**
- `qty` field value is less than `20` **and**
- `sale` field value is equal to `true`.

MongoDB provides an implicit `AND` operation when specifying a comma separated list of expressions. For example, you may write the above query as:

```
db.inventory.find( { price: 1.99, qty: { $lt: 20 } , sale: true } )
```

If, however, a query requires an AND operation on the same field such as `{ price: { $ne: 1.99 } } AND { price: { $exists: true } }`, then either use the $and (page 692) operator for the two separate expressions or combine the operator expressions for the field `{ price: { $ne: 1.99, $exists: true } }`.

Consider the following examples:

```
db.inventory.update( { $and: [ { price: { $ne: 1.99 } }, { price: { $exists: true } } ] }, {
```

```
db.inventory.update( { price: { $ne: 1.99, $exists: true } } , { $set: { qty: 15 } } )
```

Both update() (page 842) operations will set the value of the qty field in documents where:

–the price field value does not equal 1.99 **and**

–the price field exists.

See Also:

find() (page 820), update() (page 842), $ne (page 704), $exists (page 695), $set (page 716).

$bit

$bit

The $bit (page 693) operator performs a bitwise update of a field. Only use this with integer fields. For example:

```
db.collection.update( { field: 1 }, { $bit: { field: { and: 5 } } } );
```

Here, the $bit (page 693) operator updates the integer value of the field named field with a bitwise and: 5 operation. This operator only works with number types.

$box

$box

New in version 1.4. The $box (page 693) operator specifies a rectangular shape for the $within (page 721) operator in *geospatial* queries. To use the $box (page 693) operator, you must specify the bottom left and top right corners of the rectangle in an array object. Consider the following example:

```
db.collection.find( { loc: { $within: { $box: [ [0,0], [100,100] ] } } } )
```

This will return all the documents that are within the box having points at: [0,0], [0,100], [100,0], and [100,100]. Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$center

$center

New in version 1.4. This specifies a circle shape for the $within (page 721) operator in *geospatial* queries. To define the bounds of a query using $center (page 694), you must specify:

–the center point, and

–the radius

Considering the following example:

```
db.collection.find( { location: { $within: { $center: [ [0,0], 10 ] } } } );
```

The above command returns all the documents that fall within a 10 unit radius of the point [0,0]. Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$centerSphere

$centerSphere

New in version 1.8. The $centerSphere (page 694) operator is the spherical equivalent of the $center (page 694) operator. $centerSphere (page 694) uses spherical geometry to define a circle for use by the $within (page 721) operator in *geospatial* queries.

To define the bounds of a query using $centerSphere (page 694), you must specify:

–The center point

–The angular distance in radians (distance along the surface of the earth).

Consider the following prototype:

```
db.collection.find( { loc: { $within:
                             { $centerSphere:
                               [ [<long>,<lat>], <distance> / <radius> ]
                             } } } )
```

The following example returns all documents within a 10 mile radius of longitude 88 W and latitude 30 N. MongoDB converts the distance, 10 miles, to radians by dividing by the approximate radius of the earth, 3959 miles:

```
db.collection.find( { loc: { $within:
                             { $centerSphere:
                                [ [88,30], 10 / 3959 ]
                             } } } )
```

Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$comment

$comment

The $comment (page 695) makes it possible to attach a comment to a query. Because these comments propagate to the profile (page 783) log, adding $comment (page 695) modifiers can make your profile data much easier to interpret and trace. Use one of the following forms:

```
db.collection.find( { <query> } )._addSpecial( "$comment", <comment> )
db.collection.find( { $query: { <query> }, $comment: <comment> } )
```

$each

Note: The $each (page 695) operator is only used with the $addToSet (page 691) see the documentation of *$addToSet* (page 691) for more information.

$each

The $each (page 695) operator is available within the $addToSet (page 691), which allows you to add multiple values to the array if they do not exist in the field array in a single operation. Consider the following prototype:

```
db.collection.update( { field: value }, { $addToSet: { field: { $each : [ value1, value2, va
```

$elemMatch (query)

See Also:

$elemMatch (projection) (page 722)

$elemMatch

New in version 1.4. The $elemMatch (page 695) operator matches more than one component within an array element. For example,

```
db.collection.find( { array: { $elemMatch: { value1: 1, value2: { $gt: 1 } } } } );
```

returns all documents in collection where the array array satisfies all of the conditions in the $elemMatch (page 695) expression, or where the value of value1 is 1 and the value of value2 is greater than 1. Matching arrays must have at least one element that matches all specified criteria. Therefore, the following document would not match the above query:

```
{ array: [ { value1:1, value2:0 }, { value1:2, value2:2 } ] }
```

while the following document would match this query:

```
{ array: [ { value1:1, value2:0 }, { value1:1, value2:2 } ] }
```

$exists

$exists

Syntax: { field: { $exists: <boolean> } }

$exists (page 695) selects the documents that contain the field if <boolean> is true. If <boolean> is false, the query only returns the documents that do not contain the field. Documents that contain the field but has the value null are *not* returned.

MongoDB *$exists* does **not** correspond to SQL operator exists. For SQL exists, refer to the $in (page 698) operator.

Consider the following example:

```
db.inventory.find( { qty: { $exists: true, $nin: [ 5, 15 ] } } )
```

This query will select all documents in the inventory collection where the qty field exists *and* its value does not equal either 5 nor 15.

See Also:

- find() (page 820)
- $nin (page 705)
- $and (page 692)
- $in (page 698)
- *How do I query for fields that have null values?* (page 646)

$explain

$explain

The $explain (page 696) operator provides information on the query plan. It returns a *document* (page 1006) that describes the process and indexes used to return the query. This may provide useful insight when attempting to optimize a query.

mongo (page 908) shell also provides the explain() (page 805) method:

```
db.collection.find().explain()
```

You can also specify the option in either of the following forms:

```
db.collection.find()._addSpecial( "$explain", 1 )
db.collection.find( { $query: {}, $explain: 1 } )
```

For details on the output, see *Explain Output* (page 1006).

$explain (page 696) runs the actual query to determine the result. Although there are some differences between running the query with $explain (page 696) and running without, generally, the performance will be similar between the two. So, if the query is slow, the $explain (page 696) operation is also slow.

Additionally, the $explain (page 696) operation reevaluates a set of candidate query plans, which may cause the $explain (page 696) operation to perform differently than a normal query. As a result, these operations generally provide an accurate account of *how* MongoDB would perform the query, but do not reflect the length of these queries.

To determine the performance of a particular index, you can use hint() (page 806) and in conjunction with explain() (page 805), as in the following example:

```
db.products.find().hint( { type: 1 } ).explain()
```

When you run explain() (page 805) with hint() (page 806), the query optimizer does not reevaluate the query plans.

Note: In some situations, the `explain()` (page 805) operation may differ from the actual query plan used by MongoDB in a normal query.

The `explain()` (page 805) operation evaluates the set of query plans and reports on the winning plan for the query. In normal operations the query optimizer caches winning query plans and uses them for similar related queries in the future. As a result MongoDB may sometimes select query plans from the cache that are different from the plan displayed using `explain()` (page 805).

See Also:

- `cursor.explain()` (page 805)
- *Optimization Strategies for MongoDB Applications* (page 435) page for information regarding optimization strategies.
- *Analyze Performance of Database Operations* (page 616) tutorial for information regarding the database profile.
- *Current Operation Reporting* (page 998)

$gt

$gt

Syntax: `{field: {$gt: value} }`

`$gt` (page 697) selects those documents where the value of the `field` is greater than (i.e. >) the specified `value`.

Consider the following example:

```
db.inventory.find( { qty: { $gt: 20 } } )
```

This query will select all documents in the `inventory` collection where the `qty` field value is greater than `20`.

Consider the following example which uses the `$gt` (page 697) operator with a field from an embedded document:

```
db.inventory.update( { "carrier.fee": { $gt: 2 } }, { $set: { price: 9.99 } } )
```

This `update()` (page 842) operation will set the value of the `price` field in the documents that contain the embedded document `carrier` whose `fee` field value is greater than `2`.

See Also:

`find()` (page 820), `update()` (page 842), `$set` (page 716).

$gte

$gte

Syntax: `{field: {$gte: value} }`

`$gte` (page 697) selects the documents where the value of the `field` is greater than or equal to (i.e. >=) a specified value (e.g. `value`.)

Consider the following example:

```
db.inventory.find( { qty: { $gte: 20 } } )
```

This query would select all documents in `inventory` where the `qty` field value is greater than or equal to `20`.

Consider the following example which uses the `$gte` (page 697) operator with a field from an embedded document:

```
db.inventory.update( { "carrier.fee": { $gte: 2 } }, { $set: { price: 9.99 } } )
```

This `update()` (page 842) operation will set the value of the `price` field that contain the embedded document `carrier` whose `fee` field value is greater than or equal to `2`.

See Also:

`find()` (page 820), `update()` (page 842), `$set` (page 716).

$hint

$hint

The `$hint` (page 698) operator forces the *query optimizer* (page 118) to use a specific index to fulfill the query. Specify the index either by the index name or by the index specification document. See *Index Specification Documents* (page 140) for information on index specification documents.

Use `$hint` (page 698) for testing query performance and indexing strategies. The `mongo` (page 908) shell provides a helper method `hint()` (page 806) for the `$hint` (page 698) operator.

Consider the following operation:

```
db.users.find().hint( { age: 1 } )
```

This operation returns all documents in the collection named `users` using the index on the `age` field.

You can also specify a hint using either of the following forms:

```
db.users.find()._addSpecial( "$hint", { age : 1 } )
db.users.find( { $query: {}, $hint: { age : 1 } } )
```

Note: To combine `$explain` (page 696) and `$hint` (page 698) operations, use the following form:

```
db.users.find( { $query: {}, $hint: { age : 1 } } )
```

You must add the `$explain` (page 696) option to the document, as in the following:

```
db.users.find( { $query: {}, $hint: { age : 1 }, $explain: 1 } )
```

$in

$in

Syntax: `{ field: { $in: [<value1>, <value2>, ... <valueN> ] } }`

`$in` (page 698) selects the documents where the `field` value equals any value in the specified array (e.g. `<value1>`, `<value2>`, etc.)

Consider the following example:

```
db.inventory.find( { qty: { $in: [ 5, 15 ] } } )
```

This query selects all documents in the `inventory` collection where the `qty` field value is either `5` or `15`. Although you can express this query using the `$or` (page 707) operator, choose the `$in` (page 698) operator rather than the `$or` (page 707) operator when performing equality checks on the same field.

If the `field` holds an array, then the `$in` (page 698) operator selects the documents whose `field` holds an array that contains at least one element that matches a value in the specified array (e.g. `<value1>`, `<value2>`, etc.)

Consider the following example:

```
db.inventory.update( { tags: { $in: ["appliances", "school"] } }, { $set: { sale:true } } )
```

This `update()` (page 842) operation will set the `sale` field value in the `inventory` collection where the `tags` field holds an array with at least one element matching an element in the array `["appliances", "school"]`.

See Also:

`find()` (page 820), `update()` (page 842), `$or` (page 707), `$set` (page 716).

$inc

$inc

The `$inc` (page 699) operator increments a value of a field by a specified amount. If the field does not exist, `$inc` (page 699) sets the field to the specified amount. `$inc` (page 699) accepts positive and negative incremental amounts.

The following example increments the value of `field1` by the value of `amount` for the *first* matching document in the collection where `field` equals `value`:

```
db.collection.update( { field: value },
                      { $inc: { field1: amount } } );
```

To update all matching documents in the collection, specify `multi:true` in the `update()` (page 842) method:

```
db.collection.update( { age: 20 }, { $inc: { age: 1 } }, { multi: true } );
db.collection.update( { name: "John" }, { $inc: { age: 2 } }, { multi: true } );
```

The first `update()` (page 842) operation increments the value of the `age` field by `1` for all documents in the collection that have an `age` field equal to `20`. The second operation increments the value of the `age` field by `2` for all documents in the collection with the `name` field equal to `"John"`.

$isolated

$isolated

`$isolated` (page 699) isolation operator **isolates** a write operation that affects multiple documents from other write operations.

Note: The `$isolated` (page 699) isolation operator does **not** provide "all-or-nothing" atomicity for write operations.

Consider the following example:

```
db.foo.update( { field1 : 1 , $isolated : 1 }, { $inc : { field2 : 1 } } , { multi: true } )
```

Without the $isolated (page 699) operator, multi-updates will allow other operations to interleave with this updates. If these interleaved operations contain writes, the update operation may produce unexpected results. By specifying $isolated (page 699) you can guarantee isolation for the entire multi-update.

Warning: $isolated (page 699) does not work with *sharded clusters*.

See Also:

See db.collection.update() (page 842) for more information about the db.collection.update() (page 842) method.

$atomic

Deprecated since version 2.2: The $isolated (page 699) replaces $atomic (page 700).

$lt

$lt

Syntax: {field: {$lt: value} }

$lt (page 700) selects the documents where the value of the field is less than (i.e. <) the specified value.

Consider the following example:

```
db.inventory.find( { qty: { $lt: 20 } } )
```

This query will select all documents in the inventory collection where the qty field value is less than 20.

Consider the following example which uses the $lt (page 700) operator with a field from an embedded document:

```
db.inventory.update( { "carrier.fee": { $lt: 20 } }, { $set: { price: 9.99 } } )
```

This update() (page 842) operation will set the price field value in the documents that contain the embedded document carrier whose fee field value is less than 20.

See Also:

find() (page 820), update() (page 842), $set (page 716).

$lte

$lte

Syntax: { field: { $lte: value} }

$lte (page 700) selects the documents where the value of the field is less than or equal to (i.e. <=) the specified value.

Consider the following example:

```
db.inventory.find( { qty: { $lte: 20 } } )
```

This query will select all documents in the inventory collection where the qty field value is less than or equal to 20.

Consider the following example which uses the $lt (page 700) operator with a field from an embedded document:

```
db.inventory.update( { "carrier.fee": { $lte: 5 } }, { $set: { price: 9.99 } } )
```

This `update()` (page 842) operation will set the `price` field value in the documents that contain the embedded document `carrier` whose `fee` field value is less than or equal to `5`.

See Also:

`find()` (page 820), `update()` (page 842), `$set` (page 716).

$max

$max

Specify a `$max` (page 701) value to specify the *exclusive* upper bound for a specific index in order to constrain the results of `find()` (page 820). The `mongo` (page 908) shell provides the `cursor.max()` (page 807) wrapper method:

```
db.collection.find( { <query> } ).max( { field1: <max value>, ... fieldN: <max valueN> } )
```

You can also specify the option with either of the two forms:

```
db.collection.find( { <query> } )._addSpecial( "$max", { field1: <max value1>, ... fieldN: <
db.collection.find( { $query: { <query> }, $max: { field1: <max value1>, ... fieldN: <max va
```

The `$max` (page 701) specifies the upper bound for *all* keys of a specific index *in order*.

Consider the following operations on a collection named `collection` that has an index `{ age: 1 }`:

```
db.collection.find( { <query> } ).max( { age: 100 } )
```

This operation limits the query to those documents where the field `age` is less than `100` using the index `{ age: 1 }`.

You can explicitly specify the corresponding index with `cursor.hint()` (page 806). Otherwise, MongoDB selects the index using the fields in the `indexBounds`; however, if multiple indexes exist on same fields with different sort orders, the selection of the index may be ambiguous.

Consider a collection named `collection` that has the following two indexes:

```
{ age: 1, type: -1 }
{ age: 1, type: 1 }
```

Without explicitly using `cursor.hint()` (page 806), MongoDB may select either index for the following operation:

```
db.collection.find().max( { age: 50, type: 'B' } )
```

Use `$max` (page 701) alone or in conjunction with `$min` (page 702) to limit results to a specific range for the *same* index, as in the following example:

```
db.collection.find().min( { age: 20 } ).max( { age: 25 } )
```

Note: Because `cursor.max()` (page 807) requires an index on a field, and forces the query to use this index, you may prefer the `$lt` (page 700) operator for the query if possible. Consider the following example:

```
db.collection.find( { _id: 7 } ).max( { age: 25 } )
```

The query uses the index on the `age` field, even if the index on `_id` may be better.

$maxDistance

$maxDistance

The $maxDistance (page 702) operator specifies an upper bound to limit the results of a geolocation query. See below, where the $maxDistance (page 702) operator narrows the results of the $near (page 704) query:

```
db.collection.find( { location: { $near: [100,100], $maxDistance: 10 } } );
```

This query will return documents with location fields from collection that have values with a distance of 5 or fewer units from the point [100,100]. $near (page 704) returns results ordered by their distance from [100,100]. This operation will return the first 100 results unless you modify the query with the cursor.limit() (page 807) method.

Specify the value of the $maxDistance (page 702) argument in the same units as the document coordinate system. Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$maxScan

$maxScan

Constrains the query to only scan the specified number of documents when fulfilling the query. Use one of the following forms:

```
db.collection.find( { <query> } )._addSpecial( "$maxScan" , <number> )
db.collection.find( { $query: { <query> }, $maxScan: <number> } )
```

Use this modifier to prevent potentially long running queries from disrupting performance by scanning through too much data.

$min

$min

Specify a $min (page 702) value to specify the *inclusive* lower bound for a specific index in order to constrain the results of find() (page 820). The mongo (page 908) shell provides the cursor.min() (page 809) wrapper method:

```
db.collection.find( { <query> } ).min( { field1: <min value>, ... fieldN: <min valueN>} )
```

You can also specify the option with either of the two forms:

```
db.collection.find( { <query> } )._addSpecial( "$min", { field1: <min value1>, ... fieldN: <
db.collection.find( { $query: { <query> }, $min: { field1: <min value1>, ... fieldN: <min va
```

The $min (page 702) specifies the lower bound for *all* keys of a specific index *in order*.

Consider the following operations on a collection named collection that has an index { age: 1 }:

```
db.collection.find().min( { age: 20 } )
```

These operations limit the query to those documents where the field `age` is at least `20` using the index `{ age: 1 }`.

You can explicitly specify the corresponding index with `cursor.hint()` (page 806). Otherwise, MongoDB selects the index using the fields in the `indexBounds`; however, if multiple indexes exist on same fields with different sort orders, the selection of the index may be ambiguous.

Consider a collection named `collection` that has the following two indexes:

```
{ age: 1, type: -1 }
{ age: 1, type: 1 }
```

Without explicitly using `cursor.hint()` (page 806), it is unclear which index the following operation will select:

```
db.collection.find().min( { age: 20, type: 'C' } )
```

You can use `$min` (page 702) in conjunction with `$max` (page 701) to limit results to a specific range for the *same* index, as in the following example:

```
db.collection.find().min( { age: 20 } ).max( { age: 25 } )
```

Note: Because `cursor.min()` (page 809) requires an index on a field, and forces the query to use this index, you may prefer the `$gte` (page 697) operator for the query if possible. Consider the following example:

```
db.collection.find( { _id: 7 } ).min( { age: 25 } )
```

The query will use the index on the `age` field, even if the index on `_id` may be better.

$mod

$mod

Syntax: `{ field: { $mod: [ divisor, remainder ]} }`

`$mod` (page 703) selects the documents where the `field` value divided by the `divisor` has the specified `remainder`.

Consider the following example:

```
db.inventory.find( { qty: { $mod: [ 4, 0 ] } } )
```

This query will select all documents in the `inventory` collection where the `qty` field value modulo `4` equals `0`, such as documents with `qty` value equal to `0` or `12`.

In some cases, you can query using the `$mod` (page 703) operator rather than the more expensive `$where` (page 720) operator. Consider the following example using the `$mod` (page 703) operator:

```
db.inventory.find( { qty: { $mod: [ 4, 0 ] } } )
```

The above query is less expensive than the following query which uses the `$where` (page 720) operator:

```
db.inventory.find( { $where: "this.qty % 4 == 0" } )
```

See Also:

`find()` (page 820), `update()` (page 842), `$set` (page 716).

$natural

$natural

Use the $natural (page 704) operator to use *natural order* for the results of a sort operation. Natural order refers to the order of documents in the file on disk.

The $natural (page 704) operator uses the following syntax to return documents in the order they exist on disk:

```
db.collection.sort( { $natural: 1 } )
```

Use -1 to return documents in the reverse order as they occur on disk:

```
db.collection.sort( { $natural: -1 } )
```

See Also:

cursor.sort() (page 813)

$ne

$ne

Syntax: {field: {$ne: value} }

$ne (page 704) selects the documents where the value of the field is not equal (i.e. !=) to the specified value. This includes documents that do not contain the field.

Consider the following example:

```
db.inventory.find( { qty: { $ne: 20 } } )
```

This query will select all documents in the inventory collection where the qty field value does not equal 20, including those documents that do not contain the qty field.

Consider the following example which uses the $ne (page 704) operator with a field from an embedded document:

```
db.inventory.update( { "carrier.state": { $ne: "NY" } }, { $set: { qty: 20 } } )
```

This update() (page 842) operation will set the qty field value in the documents that contains the embedded document carrier whose state field value does not equal "NY", or where the state field or the carrier embedded document does not exist.

See Also:

find() (page 820), update() (page 842), $set (page 716).

$near

$near

The $near (page 704) operator takes an argument, coordinates for a point in the form of [x, y], and returns a list of objects sorted by distance from nearest to farthest with respect to those coordinates. See the following example:

```
db.collection.find( { location: { $near: [100,100] } } );
```

This query will return 100 ordered records with a location field in collection. Specify a different limit using the cursor.limit() (page 807), or another *geolocation operator* (page 883), or a non-geospatial operator to limit the results of the query.

Note: Specifying a batch size (i.e. `batchSize()` (page 804)) in conjunction with queries that use the `$near` (page 704) is not defined. See SERVER-5236 for more information.

Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$nearSphere

$nearSphere

New in version 1.8. The `$nearSphere` (page 705) operator is the spherical equivalent of the `$near` (page 704) operator. `$nearSphere` (page 705) returns all documents near a point, calculating distances using spherical geometry.

```
db.collection.find( { loc: { $nearSphere: [0,0] } } )
```

Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$nin

$nin

Syntax: `{ field: { $nin: [ <value1>, <value2> ... <valueN> ]} }`

`$nin` (page 705) selects the documents where:

– the `field` value is not in the specified `array` **or**

– the `field` does not exist.

Consider the following query:

```
db.inventory.find( { qty: { $nin: [ 5, 15 ] } } )
```

This query will select all documents in the `inventory` collection where the `qty` field value does **not** equal `5` nor `15`. The selected documents will include those documents that do *not* contain the `qty` field.

If the `field` holds an array, then the `$nin` (page 705) operator selects the documents whose `field` holds an array with **no** element equal to a value in the specified array (e.g. `<value1>`, `<value2>`, etc.).

Consider the following query:

```
db.inventory.update( { tags: { $nin: [ "appliances", "school" ] } }, { $set: { sale: false }
```

This update() (page 842) operation will set the sale field value in the inventory collection where the tags field holds an array with **no** elements matching an element in the array ["appliances", "school"] or where a document does not contain the tags field.

See Also:

find() (page 820), update() (page 842), $set (page 716).

$nor

$nor

Syntax: { $nor: [{ <expression1> }, { <expression2> }, ... { <expressionN> }] }

$nor (page 706) performs a logical NOR operation on an array of *two or more* <expressions> and selects the documents that **fail** all the <expressions> in the array.

Consider the following example:

```
db.inventory.find( { $nor: [ { price: 1.99 }, { qty: { $lt: 20 } }, { sale: true } ] } )
```

This query will select all documents in the inventory collection where:

- the price field value does *not* equal 1.99 **and**
- the qty field value is *not* less than 20 **and**
- the sale field value is *not* equal to true

including those documents that do not contain these field(s).

The exception in returning documents that do not contain the field in the $nor (page 706) expression is when the $nor (page 706) operator is used with the $exists (page 695) operator.

Consider the following query which uses only the $nor (page 706) operator:

```
db.inventory.find( { $nor: [ { price: 1.99 }, { sale: true } ]  } )
```

This query will return all documents that:

- contain the price field whose value is *not* equal to 1.99 and contain the sale field whose value *is not* equal to true **or**
- contain the price field whose value is *not* equal to 1.99 *but* do *not* contain the sale field **or**
- do *not* contain the price field *but* contain the sale field whose value *is not* equal to true **or**
- do *not* contain the price field *and* do *not* contain the sale field

Compare that with the following query which uses the $nor (page 706) operator with the $exists (page 695) operator:

```
db.inventory.find( { $nor: [ { price: 1.99 }, { price: { $exists: false } },
                             { sale: true }, { sale: { $exists: false } } ] } )
```

This query will return all documents that:

- contain the price field whose value is *not* equal to 1.99 and contain the sale field whose value *is not* equal to true

See Also:

find() (page 820), update() (page 842), $set (page 716), $exists (page 695).

$not

$not

Syntax: `{ field: { $not: { <operator-expression> } } }`

`$not` (page 707) performs a logical `NOT` operation on the specified `<operator-expression>` and selects the documents that do *not* match the `<operator-expression>`. This includes documents that do not contain the `field`.

Consider the following query:

```
db.inventory.find( { price: { $not: { $gt: 1.99 } } } )
```

This query will select all documents in the `inventory` collection where:

–the `price` field value is less than or equal to `1.99` **or**

–the `price` field does not exist

`{ $not: { $gt: 1.99 } }` is different from the `$lte` (page 700) operator. `{ $lt: 1.99 }` returns *only* the documents where `price` field exists and its value is less than or equal to `1.99`.

Remember that the `$not` (page 707) operator only affects *other operators* and cannot check fields and documents independently. So, use the `$not` (page 707) operator for logical disjunctions and the `$ne` (page 704) operator to test the contents of fields directly.

Consider the following behaviors when using the `$not` (page 707) operator:

–The operation of the `$not` (page 707) operator is consistent with the behavior of other operators but may yield unexpected results with some data types like arrays.

–The `$not` (page 707) operator does **not** support operations with the `$regex` (page 713) operator. Instead use `http://docs.mongodb.org/v2.2//` or in your driver interfaces, use your language's regular expression capability to create regular expression objects.

Consider the following example which uses the pattern match expression `http://docs.mongodb.org/v2.2//`:

```
db.inventory.find( { item: { $not: /^p.*/ } } )
```

The query will select all documents in the `inventory` collection where the `item` field value does *not* start with the letter `p`.

If you are using Python, you can write the above query with the PyMongo driver and Python's `python:re.compile()` method to compile a regular expression, as follows:

```
import re
for noMatch in db.inventory.find( { "item": { "$not": re.compile("^p.*") } } ):
    print noMatch
```

See Also:

`find()` (page 820), `update()` (page 842), `$set` (page 716), `$gt` (page 697), `$regex` (page 713), PyMongo, *driver*.

$or

$or

New in version 1.6.Changed in version 2.0: You may nest `$or` (page 707) operations; however, these

expressions are not as efficiently optimized as top-level. *Syntax*: `{ $or: [ { <expression1> }, { <expression2> }, ... , { <expressionN> } ] }`

The `$or` (page 707) operator performs a logical `OR` operation on an array of *two or more* `<expressions>` and selects the documents that satisfy *at least* one of the `<expressions>`.

Consider the following query:

```
db.inventory.find( { price:1.99, $or: [ { qty: { $lt: 20 } }, { sale: true } ] } )
```

This query will select all documents in the `inventory` collection where:

–the `price` field value equals `1.99` *and*

–either the `qty` field value is less than `20` **or** the `sale` field value is `true`.

Consider the following example which uses the `$or` (page 707) operator to select fields from embedded documents:

```
db.inventory.update( { $or: [ { price:10.99 }, { "carrier.state": "NY"} ] }, { $set: { sale:
```

This `update()` (page 842) operation will set the value of the `sale` field in the documents in the `inventory` collection where:

–the `price` field value equals `10.99` **or**

–the `carrier` embedded document contains a field `state` whose value equals `NY`.

When using `$or` (page 707) with `<expressions>` that are equality checks for the value of the same field, choose the `$in` (page 698) operator over the `$or` (page 707) operator.

Consider the query to select all documents in the `inventory` collection where:

–either `price` field value equals `1.99` *or* the `sale` field value equals `true`, **and**

–either `qty` field value equals `20` *or* `qty` field value equals `50`,

The most effective query would be:

```
db.inventory.find ( { $or: [ { price: 1.99 }, { sale: true } ], qty: { $in: [20, 50] } } )
```

Consider the following behaviors when using the `$or` (page 707) operator:

–When using indexes with `$or` (page 707) queries, remember that each clause of an `$or` (page 707) query will execute in parallel. These clauses can each use their own index. Consider the following query:

```
db.inventory.find ( { $or: [ { price: 1.99 }, { sale: true } ] } )
```

For this query, you would create one index on `price` (`db.inventory.ensureIndex( { price: 1 } )`) and another index on `sale` (`db.inventory.ensureIndex( { sale: 1 } )`) rather than a compound index.

–Also, when using the `$or` (page 707) operator with the `sort()` (page 813) method in a query, the query will **not** use the indexes on the `$or` (page 707) fields. Consider the following query which adds a `sort()` (page 813) method to the above query:

```
db.inventory.find ( { $or: [ { price: 1.99 }, { sale: true } ] } ).sort({item:1})
```

This modified query will not use the index on `price` nor the index on `sale`.

–You cannot use the `$or` (page 707) with `2d` *geospatial queries* (page 269).

See Also:

find() (page 820), update() (page 842), $set (page 716), $and (page 692), sort() (page 813).

$orderby

$orderby

The $orderby (page 709) operator sorts the results of a query in ascending or descending order.

The mongo (page 908) shell provides the cursor.sort() (page 813) method:

```
db.collection.find().sort( { age: -1 } )
```

You can also specify the option in either of the following forms:

```
db.collection.find()._addSpecial( "$orderby", { age : -1 } )
db.collection.find( { $query: {}, $orderby: { age : -1 } } )
```

These examples return all documents in the collection named collection sorted by the age field in descending order. Specify a value to $orderby (page 709) of negative one (e.g. -1, as above) to sort in descending order or a positive value (e.g. 1) to sort in ascending order.

Unless you have a index for the specified key pattern, use $orderby (page 709) in conjunction with $maxScan (page 702) and/or cursor.limit() (page 807) to avoid requiring MongoDB to perform a large in-memory sort. The cursor.limit() (page 807) increases the speed and reduces the amount of memory required to return this query by way of an optimized algorithm.

$polygon

$polygon

New in version 1.9. Use $polygon (page 709) to specify a polygon for a bounded query using the $within (page 721) operator for *geospatial* queries. To define the polygon, you must specify an array of coordinate points, as in the following:

[[x1,y1], [x2,y2], [x3,y3]]

The last point specified is always implicitly connected to the first. You can specify as many points, and therefore sides, as you like. Consider the following bounded query for documents with coordinates within a polygon:

```
db.collection.find( { loc: { $within: { $polygon: [ [0,0], [3,6], [6,0]  ] } } } )
```

Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$pop

$pop

The $pop (page 709) operator removes the first or last element of an array. Pass $pop (page 709) a value

of 1 to remove the last element in an array and a value of -1 to remove the first element of an array. Consider the following syntax:

```
db.collection.update( {field: value }, { $pop: { field: 1 } } );
```

This operation removes the last item of the array in field in the document that matches the query statement { field: value }. The following example removes the *first* item of the same array:

```
db.collection.update( {field: value }, { $pop: { field: -1 } } );
```

Be aware of the following $pop (page 709) behaviors:

- The $pop (page 709) operation fails if field is not an array.
- $pop (page 709) will successfully remove the last item in an array. field will then hold an empty array.

New in version 1.1.

$ (query)

$

Syntax: { "<array>.$" : value }

The positional $ (page 710) operator identifies an element in an array field to update without explicitly specifying the position of the element in the array. To project, or return, an array element from a read operation, see the $ (page 724) projection operator.

When used with the update() (page 842) method,

- the positional $ (page 710) operator acts as a placeholder for the **first** element that matches the *query document* (page 139), and
- the array field **must** appear as part of the query document.

```
db.collection.update( { <array>: value ... }, { <update operator>: { "<array>.$" : value } }
```

Consider a collection students with the following documents:

```
{ "_id" : 1, "grades" : [ 80, 85, 90 ] }
{ "_id" : 2, "grades" : [ 88, 90, 92 ] }
{ "_id" : 3, "grades" : [ 85, 100, 90 ] }
```

To update 80 to 82 in the grades array in the first document, use the positional $ (page 710) operator if you do not know the position of the element in the array:

```
db.students.update( { _id: 1, grades: 80 }, { $set: { "grades.$" : 82 } } )
```

Remember that the positional $ (page 710) operator acts as a placeholder for the **first match** of the update *query document* (page 139).

The positional $ (page 710) operator facilitates updates to arrays that contain embedded documents. Use the positional $ (page 710) operator to access the fields in the embedded documents with the *dot notation* (page 137) on the $ (page 710) operator.

```
db.collection.update( { <query selector> }, { <update operator>: { "array.$.field" : value }
```

Consider the following document in the students collection whose grades field value is an array of embedded documents:

```
{ "_id" : 4, "grades" : [ { grade: 80, mean: 75, std: 8 },
                          { grade: 85, mean: 90, std: 5 },
                          { grade: 90, mean: 85, std: 3 } ] }
```

Use the positional `$` (page 710) operator to update the value of the `std` field in the embedded document with the `grade` of `85`:

```
db.students.update( { _id: 4, "grades.grade": 85 }, { $set: { "grades.$.std" : 6 } } )
```

Note:

- Do not use the positional operator `$` (page 710) with *upsert* operations because inserts will use the `$` as a field name in the inserted document.
- When used with the `$unset` (page 720) operator, the positional `$` (page 710) operator does not remove the matching element from the array but rather sets it to `null`.

See Also:

`update()` (page 842), `$set` (page 716) and `$unset` (page 720)

$pull

$pull

The `$pull` (page 711) operator removes all instances of a value from an existing array. Consider the following example:

```
db.collection.update( { field: value }, { $pull: { field: value1 } } );
```

`$pull` (page 711) removes the value `value1` from the array in `field`, in the document that matches the query statement `{ field: value }` in `collection`. If `value1` existed multiple times in the `field` array, `$pull` (page 711) would remove all instances of `value1` in this array.

$pullAll

$pullAll

The `$pullAll` (page 711) operator removes multiple values from an existing array. `$pullAll` (page 711) provides the inverse operation of the `$pushAll` (page 712) operator. Consider the following example:

```
db.collection.update( { field: value }, { $pullAll: { field1: [ value1, value2, value3 ] } }
```

Here, `$pullAll` (page 711) removes `[ value1, value2, value3 ]` from the array in `field1`, in the document that matches the query statement `{ field: value }` in `collection`.

$push

$push

The `$push` (page 711) operator appends a specified value to an array. For example:

```
db.collection.update( { field: value }, { $push: { field: value1 } } );
```

Here, `$push` (page 711) appends `value1` to the array identified by `value` in `field`. Be aware of the following behaviors:

– If the field specified in the $push (page 711) statement (e.g. { $push: { field: value1 } }) does not exist in the matched document, the operation adds a new array with the specified field and value (e.g. value1) to the matched document.

– The operation will fail if the field specified in the $push (page 711) statement is *not* an array. $push (page 711) does not fail when pushing a value to a non-existent field.

– If value1 is an array itself, $push (page 711) appends the whole array as an element in the identified array. To add multiple items to an array, use $pushAll (page 712).

$pushAll

$pushAll

The $pushAll (page 712) operator is similar to the $push (page 711) but adds the ability to append several values to an array at once.

```
db.collection.update( { field: value }, { $pushAll: { field1: [ value1, value2, value3 ] } } )
```

Here, $pushAll (page 712) appends the values in [value1, value2, value3] to the array in field1 in the document matched by the statement { field: value } in collection.

If you specify a single value, $pushAll (page 712) will behave as $push (page 711).

$query

$query

The $query (page 712) operator provides an interface to describe queries. Consider the following operation:

```
db.collection.find( { $query: { age : 25 } } )
```

This is equivalent to the following db.collection.find() (page 820) method that may be more familiar to you:

```
db.collection.find( { age : 25 } )
```

These operations return only those documents in the collection named collection where the age field equals 25.

Note: Do not mix query forms. If you use the $query (page 712) format, do not append *cursor methods* (page 890) to the find() (page 820). To modify the query use the *meta-query operators* (page 885), such as $explain (page 696).

Therefore, the following two operations are equivalent:

```
db.collection.find( { $query: { age : 25 }, $explain: true } )
db.collection.find( { age : 25 } ).explain()
```

See Also:

For more information about queries in MongoDB see *Read* (page 159), *Read Operations* (page 111), db.collection.find() (page 820), and *Getting Started with MongoDB Development* (page 20).

$regex

$regex

The $regex (page 713) operator provides regular expression capabilities for pattern matching *strings* in queries. MongoDB uses Perl compatible regular expressions (i.e. "PCRE.")

You can specify regular expressions using regular expression objects or using the $regex (page 713) operator. The following examples are equivalent:

```
db.collection.find( { field: /acme.*corp/i } );
db.collection.find( { field: { $regex: 'acme.*corp', $options: 'i' } } );
```

These expressions match all documents in collection where the value of field matches the case-insensitive regular expression acme.*corp.

$regex (page 713) uses "Perl Compatible Regular Expressions" (PCRE) as the matching engine.

$options

$regex (page 713) provides four option flags:

- i toggles case insensitivity, and allows all letters in the pattern to match upper and lower cases.
- m toggles multiline regular expression. Without this option, all regular expression match within one line.

  If there are no newline characters (e.g. \n) or no start/end of line construct, the m option has no effect.
- x toggles an "extended" capability. When set, $regex (page 713) ignores all white space characters unless escaped or included in a character class.

  Additionally, it ignores characters between an un-escaped # character and the next new line, so that you may include comments in complicated patterns. This only applies to data characters; white space characters may never appear within special character sequences in a pattern.

  The x option does not affect the handling of the VT character (i.e. code 11.)

New in version 1.9.0.

- s allows the dot (e.g. .) character to match all characters *including* newline characters.

$regex (page 713) only provides the i and m options for the native JavaScript regular expression objects (e.g. http://docs.mongodb.org/v2.2/acme.*corp/i). To use x and s you must use the "$regex (page 713)" operator with the "$options (page 713)" syntax.

To combine a regular expression match with other operators, you need to use the "$regex (page 713)" operator. For example:

```
db.collection.find( { field: { $regex: /acme.*corp/i, $nin: [ 'acmeblahcorp' ] } );
```

This expression returns all instances of field in collection that match the case insensitive regular expression acme.*corp that *don't* match acmeblahcorp.

$regex (page 713) can only use an *index* efficiently when the regular expression has an anchor for the beginning (i.e. ^) of a string and is a case-sensitive match. Additionally, while http://docs.mongodb.org/v2.2/^a/, http://docs.mongodb.org/v2.2/^a.*/, and http://docs.mongodb.org/v2.2/^a.*$/ match equivalent strings, they have different performance characteristics. All of these expressions use an index if an appropriate index exists; however, http://docs.mongodb.org/v2.2/^a.*/, and http://docs.mongodb.org/v2.2/^a.*$/ are slower. http://docs.mongodb.org/v2.2/^a/ can stop scanning after matching the prefix.

$rename

$rename

New in version 1.7.2. *Syntax*: `{$rename: { <old name1>: <new name1>, <old name2>: <new name2>, ... } }`

The `$rename` (page 714) operator updates the name of a field. The new field name must differ from the existing field name.

Consider the following example:

```
db.students.update( { _id: 1 }, { $rename: { 'nickname': 'alias', 'cell': 'mobile' } } )
```

This operation renames the field `nickname` to `alias`, and the field `cell` to `mobile`.

If the document already has a field with the *new* field name, the `$rename` (page 714) operator removes that field and renames the field with the *old* field name to the *new* field name.

The `$rename` (page 714) operator will expand arrays and sub-documents to find a match for field names. When renaming a field in a sub-document to another sub-document or to a regular field, the sub-document itself remains.

Consider the following examples involving the sub-document of the following document:

```
{ "_id": 1,
  "alias": [ "The American Cincinnatus", "The American Fabius" ],
  "mobile": "555-555-5555",
  "nmae": { "first" : "george", "last" : "washington" }
}
```

- To rename a sub-document, call the `$rename` (page 714) operator with the name of the sub-document as you would any other field:

  ```
  db.students.update( { _id: 1 }, { $rename: { "nmae": "name" } } )
  ```

  This operation renames the sub-document `nmae` to `name`:

  ```
  { "_id": 1,
    "alias": [ "The American Cincinnatus", "The American Fabius" ],
    "mobile": "555-555-5555",
    "name": { "first" : "george", "last" : "washington" }
  }
  ```

- To rename a field within a sub-document, call the `$rename` (page 714) operator using the *dot notation* (page 137) to refer to the field. Include the name of the sub-document in the new field name to ensure the field remains in the sub-document:

  ```
  db.students.update( { _id: 1 }, { $rename: { "name.first": "name.fname" } } )
  ```

  This operation renames the sub-document field `first` to `fname`:

  ```
  { "_id" : 1,
    "alias" : [ "The American Cincinnatus", "The American Fabius" ],
    "mobile" : "555-555-5555",
    "name" : { "fname" : "george", "last" : "washington" }
  }
  ```

– To rename a field within a sub-document and move it to another sub-document, call the `$rename` (page 714) operator using the *dot notation* (page 137) to refer to the field. Include the name of the new sub-document in the `new name`:

```
db.students.update( { _id: 1 }, { $rename: { "name.last": "contact.lname" } } )
```

This operation renames the sub-document field `last` to `lname` and moves it to the sub-document `contact`:

```
{ "_id" : 1,
  "alias" : [ "The American Cincinnatus", "The American Fabius" ],
  "contact" : { "lname" : "washington" },
  "mobile" : "555-555-5555",
  "name" : { "fname" : "george" }
}
```

If the new field name does not include a sub-document name, the field moves out of the subdocument and becomes a regular document field.

Consider the following behavior when the specified old field name does not exist:

– When renaming a single field and the existing field name refers to a non-existing field, the `$rename` (page 714) operator does nothing, as in the following:

```
db.students.update( { _id: 1 }, { $rename: { 'wife': 'spouse' } } )
```

This operation does nothing because there is no field named `wife`.

– When renaming multiple fields and **all** of the old field names refer to non-existing fields, the `$rename` (page 714) operator does nothing, as in the following:

```
db.students.update( { _id: 1 }, { $rename: { 'wife': 'spouse',
                                             'vice': 'vp',
                                             'office': 'term' } } )
```

This operation does nothing because there are no fields named `wife`, `vice`, and `office`.

– When renaming multiple fields and **some** but not all old field names refer to non-existing fields, the `$rename` (page 714) operator performs the following operations: Changed in version 2.2.

* Renames the fields that exist to the specified new field names.
* Ignores the non-existing fields.

Consider the following query that renames both an existing field `mobile` and a non-existing field `wife`. The field named `wife` does not exist and `$rename` (page 714) sets the field to a name that already exists `alias`.

```
db.students.update( { _id: 1 }, { $rename: { 'wife': 'alias',
                                             'mobile': 'cell' } } )
```

This operation renames the `mobile` field to `cell`, and has no other impact action occurs.

```
{ "_id" : 1,
  "alias" : [ "The American Cincinnatus", "The American Fabius" ],
  "cell" : "555-555-5555",
  "name" : { "lname" : "washington" },
```

```
  "places" : { "d" : "Mt Vernon", "b" : "Colonial Beach" }
}
```

Note: Before version 2.2, when renaming multiple fields and only some (but not all) old field names refer to non-existing fields:

- For the fields with the old names that do exist, the `$rename` (page 714) operator renames these fields to the specified new field names.
- For the fields with the old names that do **not** exist:
  - **if** no field exists with the new field name, the `$rename` (page 714) operator does nothing.
  - **if** fields already exist with the new field names, the `$rename` (page 714) operator drops these fields.

Consider the following operation that renames both the field `mobile`, which exists, and the field `wife`, which does not exist. The operation tries to set the field named `wife` to `alias`, which is the name of an existing field:

```
db.students.update( { _id: 1 }, { $rename: { 'wife': 'alias', 'mobile': 'cell' } } )
```

Before 2.2, the operation renames the field `mobile` to `cell` *and* drops the `alias` field even though the field `wife` does not exist:

```
{ "_id" : 1,
  "cell" : "555-555-5555",
  "name" : { "lname" : "washington" },
  "places" : { "d" : "Mt Vernon", "b" : "Colonial Beach" }
}
```

$returnKey

`$returnKey`

Only return the index key or keys for the results of the query. If `$returnKey` (page 716) is set to `true` and the query does not use an index to perform the read operation, the returned documents will not contain any fields. Use one of the following forms:

```
db.collection.find( { <query> } )._addSpecial( "$returnKey", true )
db.collection.find( { $query: { <query> }, $returnKey: true } )
```

$set

`$set`

Use the `$set` (page 716) operator to set a particular value. The `$set` (page 716) operator requires the following syntax:

```
db.collection.update( { field: value1 }, { $set: { field1: value2 } } );
```

This statement updates in the document in `collection` where `field` matches `value1` by replacing the value of the field `field1` with `value2`. This operator will add the specified field or fields if they do not exist in this document *or* replace the existing value of the specified field(s) if they already exist.

$showDiskLoc

$showDiskLoc

$showDiskLoc (page 717) option adds a field $diskLoc to the returned documents. The $diskLoc field contains the disk location information.

The mongo (page 908) shell provides the cursor.showDiskLoc() (page 811) method:

```
db.collection.find().showDiskLoc()
```

You can also specify the option in either of the following forms:

```
db.collection.find( { <query> } )._addSpecial("$showDiskLoc" , true)
db.collection.find( { $query: { <query> }, $showDiskLoc: true } )
```

$size

$size

The $size (page 717) operator matches any array with the number of elements specified by the argument. For example:

```
db.collection.find( { field: { $size: 2 } } );
```

returns all documents in collection where field is an array with 2 elements. For instance, the above expression will return { field: [red, green] } and { field: [apple, lime] } but *not* { field: fruit } or { field: [orange, lemon, grapefruit] }. To match fields with only one element within an array use $size (page 717) with a value of 1, as follows:

```
db.collection.find( { field: { $size: 1 } } );
```

$size (page 717) does not accept ranges of values. To select documents based on fields with different numbers of elements, create a counter field that you increment when you add elements to a field.

Queries cannot use indexes for the $size (page 717) portion of a query, although the other portions of a query can use indexes if applicable.

$snapshot

$snapshot

The $snapshot (page 717) operator prevents the cursor from returning a document more than once because an intervening write operation results in a move of the document.

Even in snapshot mode, objects inserted or deleted during the lifetime of the cursor may or may not be returned.

The mongo (page 908) shell provides the cursor.snapshot() (page 812) method:

```
db.collection.find().snapshot()
```

You can also specify the option in either of the following forms:

```
db.collection.find()._addSpecial( "$snapshot", true )
db.collection.find( { $query: {}, $snapshot: true } )
```

The $snapshot (page 717) operator traverses the index on the _id field [1].

[1] You can achieve the $snapshot (page 717) isolation behavior using any *unique* index on invariable fields.

Warning:
- You cannot use `$snapshot` (page 717) with *sharded collections*.
- Do **not** use `$snapshot` (page 717) with `$hint` (page 698) or `$orderby` (page 709) (or the corresponding `cursor.hint()` (page 806) and `cursor.sort()` (page 813) methods.)

$type

$type

Syntax: `{ field: { $type: <BSON type> } }`

`$type` (page 718) selects the documents where the *value* of the `field` is the specified *BSON* type.

Consider the following example:

```
db.inventory.find( { price: { $type : 1 } } )
```

This query will select all documents in the `inventory` collection where the `price` field value is a Double.

If the `field` holds an array, the `$type` (page 718) operator performs the type check against the array elements and **not** the `field`.

Consider the following example where the `tags` field holds an array:

```
db.inventory.find( { tags: { $type : 4 } } )
```

This query will select all documents in the `inventory` collection where the `tags` array contains an element that is itself an array.

If instead you want to determine whether the `tags` field is an array type, use the `$where` (page 720) operator:

```
db.inventory.find( { $where : "Array.isArray(this.tags)" } )
```

See the SERVER-1475 for more information about the array type.

Refer to the following table for the available *BSON* types and their corresponding numbers.

Type	Number
Double	1
String	2
Object	3
Array	4
Binary data	5
Object id	7
Boolean	8
Date	9
Null	10
Regular Expression	11
JavaScript	13
Symbol	14
JavaScript (with scope)	15
32-bit integer	16
Timestamp	17
64-bit integer	18
Min key	255
Max key	127

`MinKey` and `MaxKey` compare less than and greater than all other possible *BSON* element values, respectively, and exist primarily for internal use.

Note: To query if a field value is a `MinKey`, you must use the `$type` (page 718) with `-1` as in the following example:

```
db.collection.find( { field: { $type: -1 } } )
```

Example

Consider the following example operation sequence that demonstrates both type comparison *and* the special `MinKey` and `MaxKey` values:

```
db.test.insert( {x : 3});
db.test.insert( {x : 2.9} );
db.test.insert( {x : new Date()} );
db.test.insert( {x : true } );
db.test.insert( {x : MaxKey } )
db.test.insert( {x : MinKey } )

db.test.find().sort({x:1})
{ "_id" : ObjectId("4b04094b7c65b846e2090112"), "x" : { $minKey : 1 } }
{ "_id" : ObjectId("4b03155dce8de6586fb002c7"), "x" : 2.9 }
{ "_id" : ObjectId("4b03154cce8de6586fb002c6"), "x" : 3 }
{ "_id" : ObjectId("4b031566ce8de6586fb002c9"), "x" : true }
{ "_id" : ObjectId("4b031563ce8de6586fb002c8"), "x" : "Tue Jul 25 2012 18:42:03 GMT-0500 (ES
{ "_id" : ObjectId("4b0409487c65b846e2090111"), "x" : { $maxKey : 1 } }
```

To query for the minimum value of a *shard key* of a *sharded cluster*, use the following operation when connected to the `mongos` (page 905):

```
use config
db.chunks.find( { "min.shardKey": { $type: -1 } } )
```

Warning: Storing values of the different types in the same field in a collection is *strongly* discouraged.

See Also:

`find()` (page 820), `insert()` (page 830), `$where` (page 720), *BSON*, *shard key*, *sharded cluster* .

$uniqueDocs

`$uniqueDocs`

New in version 2.0. For *geospatial* queries, MongoDB may return a single document more than once for a single query, because geospatial indexes may include multiple coordinate pairs in a single document, and therefore return the same document more than once.

The `$uniqueDocs` (page 719) operator inverts the default behavior of the `$within` (page 721) operator. By default, the `$within` (page 721) operator returns the document only once. If you specify a value of `false` for `$uniqueDocs` (page 719), MongoDB will return multiple instances of a single document.

Example

Given an `addressBook` collection with a document in the following form:

```
{ addresses: [ { name: "Home", loc: [55.5, 42.3] }, { name: "Work", loc: [32.3, 44.2] } ] }
```

The following query would return the same document multiple times:

```
db.addressBook.find( { "addresses.loc": { "$within": { "$box": [ [0,0], [100,100] ], $unique
```

The following query would return each matching document, only once:

```
db.addressBook.find( { "address.loc": { "$within": { "$box": [ [0,0], [100,100] ], $uniqueDo
```

You cannot specify `$uniqueDocs` (page 719) with `$near` (page 704) or haystack queries. Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

$unset

$unset

The `$unset` (page 720) operator deletes a particular field. Consider the following example:

```
db.collection.update( { field: value1 }, { $unset: { field1: "" } } );
```

The above example deletes `field1` in `collection` from documents where `field` has a value of `value1`. The value of the field in the `$unset` (page 720) statement (i.e. `""` above) does not impact the operation.

If documents match the initial query (e.g. `{ field: value1 }` above) but do not have the field specified in the `$unset` (page 720) operation (e.g. `field1`), then the statement has no effect on the document.

$where

$where

Use the `$where` (page 720) operator to pass either a string containing a JavaScript expression or a full JavaScript function to the query system. The `$where` (page 720) provides greater flexibility, but requires that the database processes the JavaScript expression or function for *each* document in the collection. Reference the document in the JavaScript expression or function using either `this` or `obj` .

Warning:

- Do not write to the database within the `$where` (page 720) JavaScript function.
- `$where` (page 720) evaluates JavaScript and cannot take advantage of indexes. Therefore, query performance improves when you express your query using the standard MongoDB operators (e.g., `$gt` (page 697), `$in` (page 698)).
- In general, you should use `$where` (page 720) only when you can't express your query using another operator. If you must use `$where` (page 720), try to include at least one other standard query operator to filter the result set. Using `$where` (page 720) alone requires a table scan.

Consider the following examples:

```
db.myCollection.find( { $where: "this.credits == this.debits" } );
db.myCollection.find( { $where: "obj.credits == obj.debits" } );

db.myCollection.find( { $where: function() { return (this.credits == this.debits) } } );
db.myCollection.find( { $where: function() { return obj.credits == obj.debits; } } );
```

Additionally, if the query consists only of the $where (page 720) operator, you can pass in just the JavaScript expression or JavaScript functions, as in the following examples:

```
db.myCollection.find( "this.credits == this.debits || this.credits > this.debits" );

db.myCollection.find( function() { return (this.credits == this.debits || this.credits > thi
```

You can include both the standard MongoDB operators and the $where (page 720) operator in your query, as in the following examples:

```
db.myCollection.find( { active: true, $where: "this.credits - this.debits < 0" } );
db.myCollection.find( { active: true, $where: function() { return obj.credits - obj.debits <
```

Using normal non-$where (page 720) query statements provides the following performance advantages:

- MongoDB will evaluate non-$where (page 720) components of query before $where (page 720) statements. If the non-$where (page 720) statements match no documents, MongoDB will not perform any query evaluation using $where (page 720).
- The non-$where (page 720) query statements may use an *index*.

$within

$within

The $within (page 721) operator allows you to select items that exist within a shape on a coordinate system for *geospatial* queries. This operator uses the following syntax:

```
db.collection.find( { location: { $within: { shape } } } );
```

Replace { shape } with a document that describes a shape. The $within (page 721) command supports the following shapes. These shapes and the relevant expressions follow:

- Rectangles. Use the $box (page 693) operator, consider the following variable and $within (page 721) document:

  ```
  db.collection.find( { location: { $within: { $box: [[100,0], [120,100]] } } } );
  ```

  Here a box, [[100,120], [100,0]] describes the parameter for the query. As a minimum, you must specify the lower-left and upper-right corners of the box.

- Circles. Use the $center (page 694) operator. Specify circles in the following form:

  ```
  db.collection.find( { location: { $within: { $center: [ center, radius ] } } } );
  ```

- Circular distance on a sphere. Use the $centerSphere (page 694) operator. For the syntax, see $centerSphere (page 694).

- Polygons. Use the $polygon (page 709) operator. Specify polygons with an array of points. See the following example:

  ```
  db.collection.find( { location: { $within: { $polygon: [[100,120], [100,100], [120,100],
  ```

The last point of a polygon is implicitly connected to the first point.

All shapes include the border of the shape as part of the shape, although this is subject to the imprecision of floating point numbers.

Use $uniqueDocs (page 719) to control whether documents with many location fields show up multiple times when more than one of its fields match the query. Changed in version 2.2.3: Before 2.2.3, a geospatial index *must* exist on a field holding coordinates before using any of the geolocation query operators. After 2.2.3, applications may use geolocation query operators *without* having a geospatial index; however, geospatial indexes will support much faster geospatial queries than the unindexed equivalents.

Note: A geospatial index *must* exist on a field and the field must hold coordinates before you can use any of the geolocation query operators.

- Projection operators:

$elemMatch (projection)

See Also:

$elemMatch (query) (page 695)

$elemMatch

New in version 2.2. The $elemMatch (page 722) projection operator limits the contents of an array field that is included in the query results to contain only the array element that matches the $elemMatch (page 722) condition.

Note:

–The elements of the array are documents.

–If multiple elements match the $elemMatch (page 722) condition, the operator returns the **first** matching element in the array.

–The $elemMatch (page 722) projection operator is similar to the positional $ (page 724) projection operator.

The examples on the $elemMatch (page 722) projection operator assumes a collection school with the following documents:

```
{
 _id: 1,
 zipcode: 63109,
 students: [
              { name: "john", school: 102, age: 10 },
              { name: "jess", school: 102, age: 11 },
              { name: "jeff", school: 108, age: 15 }
           ]
}
{
 _id: 2,
 zipcode: 63110,
 students: [
              { name: "ajax", school: 100, age: 7 },
              { name: "achilles", school: 100, age: 8 },
           ]
}
```

```
{
 _id: 3,
 zipcode: 63109,
 students: [
              { name: "ajax", school: 100, age: 7 },
              { name: "achilles", school: 100, age: 8 },
           ]
}

{
 _id: 4,
 zipcode: 63109,
 students: [
              { name: "barney", school: 102, age: 7 },
           ]
}
```

Example

The following `find()` (page 820) operation queries for all documents where the value of the `zipcode` field is `63109`. The `$elemMatch` (page 722) projection returns only the **first** matching element of the `students` array where the `school` field has a value of `102`:

```
db.schools.find( { zipcode: 63109 },
                 { students: { $elemMatch: { school: 102 } } } )
```

The operation returns the following documents:

```
{ "_id" : 1, "students" : [ { "name" : "john", "school" : 102, "age" : 10 } ] }
{ "_id" : 3 }
{ "_id" : 4, "students" : [ { "name" : "barney", "school" : 102, "age" : 7 } ] }
```

- For the document with `_id` equal to `1`, the `students` array contains multiple elements with the `school` field equal to `102`. However, the `$elemMatch` (page 722) projection returns only the first matching element from the array.
- The document with `_id` equal to `3` does not contain the `students` field in the result since no element in its `students` array matched the `$elemMatch` (page 722) condition.

The `$elemMatch` (page 722) projection can specify criteria on multiple fields:

Example

The following `find()` (page 820) operation queries for all documents where the value of the `zipcode` field is `63109`. The projection includes the **first** matching element of the `students` array where the `school` field has a value of `102` **and** the `age` field is greater than `10`:

```
db.schools.find( { zipcode: 63109 },
                 { students: { $elemMatch: { school: 102, age: { $gt: 10} } } } )
```

The operation returns the three documents that have `zipcode` equal to `63109`:

```
{ "_id" : 1, "students" : [ { "name" : "jess", "school" : 102, "age" : 11 } ] }
{ "_id" : 3 }
{ "_id" : 4 }
```

Documents with `_id` equal to `3` and `_id` equal to `4` do not contain the `students` field since no element matched the `$elemMatch` (page 722) criteria.

When the `find()` (page 820) method includes a `sort()` (page 813), the `find()` (page 820) method applies the `sort()` (page 813) to order the matching documents **before** it applies the projection.

If an array field contains multiple documents with the same field name and the `find()` (page 820) method includes a `sort()` (page 813) on that repeating field, the returned documents may not reflect the sort order because the `sort()` (page 813) was applied to the elements of the array before the `$elemMatch` (page 722) projection.

Example

The following query includes a `sort()` (page 813) to order by descending `students.age` field:

```
db.schools.find(
                  { zipcode: 63109 },
                  { students: { $elemMatch: { school: 102 } } }
                ).sort( { "students.age": -1 } )
```

The operation applies the `sort()` (page 813) to order the documents that have the field `zipcode` equal to `63109` and then applies the projection. The operation returns the three documents in the following order:

```
{ "_id" : 1, "students" : [ { "name" : "john", "school" : 102, "age" : 10 } ] }
{ "_id" : 3 }
{ "_id" : 4, "students" : [ { "name" : "barney", "school" : 102, "age" : 7 } ] }
```

See Also:

`$ (projection)` (page 724) operator

$ (projection)

$

The positional `$` (page 724) operator limits the contents of the `<array>` field that is included in the query results to contain the **first** matching element. To specify an array element to update, see the *positional $ operator for updates* (page 710).

Used in the *projection* document of the `find()` (page 820) method or the `findOne()` (page 825) method:

- The `$` (page 724) projection operator limits the content of the `<array>` field to the **first** element that matches the *query document* (page 112).
- The `<array>` field **must** appear in the *query document* (page 112)

```
db.collection.find( { <array>: <value> ... },
                    { "<array>.$": 1 } )
db.collection.find( { <array.field>: <value> ...},
                    { "<array>.$": 1 } )
```

  The `<value>` can be documents that contains *query operator expressions* (page 882).

- Only **one** positional `$` (page 724) operator can appear in the projection document.
- Only **one** array field can appear in the *query document* (page 112); i.e. the following query is **incorrect**:

```
db.collection.find( { <array>: <value>, <someOtherArray>: <value2> },
                    { "<array>.$": 1 } )
```

Example

A collection `students` contains the following documents:

```
{ "_id" : 1, "semester" : 1, "grades" : [ 70, 87, 90 ] }
{ "_id" : 2, "semester" : 1, "grades" : [ 90, 88, 92 ] }
{ "_id" : 3, "semester" : 1, "grades" : [ 85, 100, 90 ] }
{ "_id" : 4, "semester" : 2, "grades" : [ 79, 85, 80 ] }
{ "_id" : 5, "semester" : 2, "grades" : [ 88, 88, 92 ] }
{ "_id" : 6, "semester" : 2, "grades" : [ 95, 90, 96 ] }
```

In the following query, the projection `{ "grades.$": 1 }` returns only the first element greater than or equal to `85` for the `grades` field.

```
db.students.find( { semester: 1, grades: { $gte: 85 } },
                  { "grades.$": 1 } )
```

The operation returns the following documents:

```
{ "_id" : 1, "grades" : [ 87 ] }
{ "_id" : 2, "grades" : [ 90 ] }
{ "_id" : 3, "grades" : [ 85 ] }
```

Although the array field `grades` may contain multiple elements that are greater than or equal to `85`, the `$` (page 724) projection operator returns only the first matching element from the array.

Important: When the `find()` (page 820) method includes a `sort()` (page 813), the `find()` (page 820) method applies the `sort()` (page 813) to order the matching documents **before** it applies the positional `$` (page 724) projection operator.

If an array field contains multiple documents with the same field name and the `find()` (page 820) method includes a `sort()` (page 813) on that repeating field, the returned documents may not reflect the sort order because the sort was applied to the elements of the array before the `$` (page 724) projection operator.

Example

A `students` collection contains the following documents where the `grades` field is an array of documents; each document contain the three field names `grade`, `mean`, and `std`:

```
{ "_id" : 7, semester: 3, "grades" : [ { grade: 80, mean: 75, std: 8 },
                                       { grade: 85, mean: 90, std: 5 },
                                       { grade: 90, mean: 85, std: 3 } ] }

{ "_id" : 8, semester: 3, "grades" : [ { grade: 92, mean: 88, std: 8 },
                                       { grade: 78, mean: 90, std: 5 },
                                       { grade: 88, mean: 85, std: 3 } ] }
```

In the following query, the projection `{ "grades.$": 1 }` returns only the first element with the `mean` greater than `70` for the `grades` field. The query also includes a `sort()` (page 813) to order by ascending `grades.grade` field:

```
db.students.find( { "grades.mean": { $gt: 70 } },
                  { "grades.$": 1 }
                ).sort( { "grades.grade": 1 } )
```

The `find()` (page 820) method sorts the matching documents **before** it applies the `$` (page 724) projection operator on the `grades` array. Thus, the results with the projected array elements do not reflect the ascending `grades.grade` sort order:

```
{ "_id" : 8, "grades" : [ { "grade" : 92, "mean" : 88, "std" : 8 } ] }
{ "_id" : 7, "grades" : [ { "grade" : 80, "mean" : 75, "std" : 8 } ] }
```

Note: Since only **one** array field can appear in the query document, if the array contains documents, to specify criteria on multiple fields of these documents, use the *$elemMatch (query)* (page 695) operator, e.g.:

```
db.students.find( { grades: { $elemMatch: {
                                            mean: { $gt: 70 },
                                            grade: { $gt:90 }
                                          } } },
                  { "grades.$": 1 } )
```

See Also:

`$elemMatch (projection)` (page 722)

$slice (projection)

`$slice`

The `$slice` (page 726) operator controls the number of items of an array that a query returns. Consider the following prototype query:

```
db.collection.find( { field: value }, { array: {$slice: count } } );
```

This operation selects the document `collection` identified by a field named `field` that holds `value` and returns the number of elements specified by the value of `count` from the array stored in the `array` field. If `count` has a value greater than the number of elements in `array` the query returns all elements of the array.

`$slice` (page 726) accepts arguments in a number of formats, including negative values and arrays. Consider the following examples:

```
db.posts.find( {}, { comments: { $slice: 5 } } )
```

Here, `$slice` (page 726) selects the first five items in an array in the `comments` field.

```
db.posts.find( {}, { comments: { $slice: -5 } } )
```

This operation returns the last five items in array.

The following examples specify an array as an argument to slice. Arrays take the form of `[ skip , limit ]`, where the first value indicates the number of items in the array to skip and the second value indicates the number of items to return.

```
db.posts.find( {}, { comments: { $slice: [ 20, 10 ] } } )
```

Here, the query will only return 10 items, after skipping the first 20 items of that array.

```
db.posts.find( {}, { comments: { $slice: [ -20, 10 ] } } )
```

This operation returns 10 items as well, beginning with the item that is 20th from the last item of the array.

- Aggregation operators:

$add (aggregation)

$add

Takes an array of one or more numbers and adds them together, returning the sum.

$addToSet (aggregation)

$addToSet

Returns an array of all the values found in the selected field among the documents in that group. *Every unique value only appears once* in the result set. There is no ordering guarantee for the output documents.

$and (aggregation)

$and

Takes an array one or more values and returns `true` if *all* of the values in the array are `true`. Otherwise `$and` (page 727) returns `false`.

Note: `$and` (page 727) uses short-circuit logic: the operation stops evaluation after encountering the first `false` expression.

$avg (aggregation)

$avg

Returns the average of all the values of the field in all documents selected by this group.

$cmp (aggregation)

$cmp

Takes two values in an array and returns an integer. The returned value is:

- A negative number if the first value is less than the second.
- A positive number if the first value is greater than the second.
- 0 if the two values are equal.

$cond (aggregation)

$cond

Use the `$cond` (page 727) operator with the following syntax:

```
{ $cond: [ <boolean-expression>, <true-case>, <false-case> ] }
```

Takes an array with three expressions, where the first expression evaluates to a Boolean value. If the first expression evaluates to true, `$cond` (page 727) returns the value of the second expression. If the first expression evaluates to false, `$cond` (page 727) evaluates and returns the third expression.

$dayOfMonth (aggregation)

`$dayOfMonth`
Takes a date and returns the day of the month as a number between 1 and 31.

$dayOfWeek (aggregation)

`$dayOfWeek`
Takes a date and returns the day of the week as a number between 1 (Sunday) and 7 (Saturday.)

$dayOfYear (aggregation)

`$dayOfYear`
Takes a date and returns the day of the year as a number between 1 and 366.

$divide (aggregation)

`$divide`
Takes an array that contains a pair of numbers and returns the value of the first number divided by the second number.

$eq (aggregation)

`$eq`
Takes two values in an array and returns a boolean. The returned value is:

- `true` when the values are equivalent.
- `false` when the values are **not** equivalent.

$first (aggregation)

`$first`
Returns the first value it encounters for its group .

Note: Only use `$first` (page 728) when the `$group` (page 728) follows an `$sort` (page 735) operation. Otherwise, the result of this operation is unpredictable.

$group (aggregation)

`$group`
Groups documents together for the purpose of calculating aggregate values based on a collection of documents. Practically, group often supports tasks such as average page views for each page in a website on a daily basis.

The output of $group (page 728) depends on how you define groups. Begin by specifying an identifier (i.e. a _id field) for the group you're creating with this pipeline. You can specify a single field from the documents in the pipeline, a previously computed value, or an aggregate key made up from several incoming fields. Aggregate keys may resemble the following document:

```
{ _id : { author: '$author', pageViews: '$pageViews', posted: '$posted' } }
```

With the exception of the _id field, $group (page 728) cannot output nested documents.

Every group expression must specify an _id field. You may specify the _id field as a dotted field path reference, a document with multiple fields enclosed in braces (i.e. { and }), or a constant value.

Note: Use $project (page 733) as needed to rename the grouped field after an $group (page 728) operation, if necessary.

Consider the following example:

```
db.article.aggregate(
    { $group : {
        _id : "$author",
        docsPerAuthor : { $sum : 1 },
        viewsPerAuthor : { $sum : "$pageViews" }
    }}
);
```

This groups by the author field and computes two fields, the first docsPerAuthor is a counter field that adds one for each document with a given author field using the $sum (page 737) function. The viewsPerAuthor field is the sum of all of the pageViews fields in the documents for each group.

Each field defined for the $group (page 728) must use one of the group aggregation function listed below to generate its composite value:

- $addToSet (page 727)
- $first (page 728)
- $last (page 730)
- $max (page 732)
- $min (page 732)
- $avg (page 727)
- $push (page 734)
- $sum (page 737)

Warning: The aggregation system currently stores $group (page 728) operations in memory, which may cause problems when processing a larger number of groups.

$gt (aggregation)

$gt

Takes two values in an array and returns an boolean. The returned value is:

- true when the first value is *greater than* the second value.
- false when the first value is *less than or equal to* the second value.

$gte (aggregation)

$gte

Takes two values in an array and returns an boolean. The returned value is:

- `true` when the first value is *greater than or equal* to the second value.
- `false` when the first value is *less than* the second value.

$hour (aggregation)

$hour

Takes a date and returns the hour between 0 and 23.

$ifNull (aggregation)

$ifNull

Use the `$ifNull` (page 730) operator with the following syntax:

```
{ $ifNull: [ <expression>, <replacement-if-null> ] }
```

Takes an array with two expressions. `$ifNull` (page 730) returns the first expression if it evaluates to a non-null value. Otherwise, `$ifNull` (page 730) returns the second expression's value.

$last (aggregation)

$last

Returns the last value it encounters for its group.

Note: Only use `$last` (page 730) when the `$group` (page 728) follows an `$sort` (page 735) operation. Otherwise, the result of this operation is unpredictable.

$limit (aggregation)

$limit

Restricts the number of *documents* that pass through the `$limit` (page 730) in the *pipeline*.

`$limit` (page 730) takes a single numeric (positive whole number) value as a parameter. Once the specified number of documents pass through the pipeline operator, no more will. Consider the following example:

```
db.article.aggregate(
    { $limit : 5 }
);
```

This operation returns only the first 5 documents passed to it from by the pipeline. `$limit` (page 730) has no effect on the content of the documents it passes.

$lt (aggregation)

$lt

Takes two values in an array and returns an boolean. The returned value is:

– `true` when the first value is *less than* the second value.

– `false` when the first value is *greater than or equal to* the second value.

$lte (aggregation)

`$lte`

Takes two values in an array and returns an boolean. The returned value is:

– `true` when the first value is *less than or equal to* the second value.

– `false` when the first value is *greater than* the second value.

$match (aggregation)

`$match`

Provides a query-like interface to filter documents out of the aggregation *pipeline*. The `$match` (page 731) drops documents that do not match the condition from the aggregation pipeline, and it passes documents that match along the pipeline unaltered.

The syntax passed to the `$match` (page 731) is identical to the *query* syntax. Consider the following prototype form:

```
db.article.aggregate(
    { $match : <match-predicate> }
);
```

The following example performs a simple field equality test:

```
db.article.aggregate(
    { $match : { author : "dave" } }
);
```

This operation only returns documents where the `author` field holds the value `dave`. Consider the following example, which performs a range test:

```
db.article.aggregate(
    { $match : { score  : { $gt : 50, $lte : 90 } } }
);
```

Here, all documents return when the `score` field holds a value that is greater than 50 and less than or equal to 90.

Note: Place the `$match` (page 731) as early in the aggregation *pipeline* as possible. Because `$match` (page 731) limits the total number of documents in the aggregation pipeline, earlier `$match` (page 731) operations minimize the amount of later processing. If you place a `$match` (page 731) at the very beginning of a pipeline, the query can take advantage of *indexes* like any other `db.collection.find()` (page 820) or `db.collection.findOne()` (page 825).

Warning: You cannot use `$where` (page 720) or *geospatial operations* (page 883) in `$match` (page 731) queries as part of the aggregation pipeline.

$max (aggregation)

$max
Returns the highest value among all values of the field in all documents selected by this group.

$min (aggregation)

$min
Returns the lowest value among all values of the field in all documents selected by this group.

$minute (aggregation)

$minute
Takes a date and returns the minute between 0 and 59.

$mod (aggregation)

$mod
Takes an array that contains a pair of numbers and returns the *remainder* of the first number divided by the second number.

See Also:

`$mod` (page 703)

$month (aggregation)

$month
Takes a date and returns the month as a number between 1 and 12.

$multiply (aggregation)

$multiply
Takes an array of one or more numbers and multiples them, returning the resulting product.

$ne (aggregation)

$ne
Takes two values in an array returns an boolean. The returned value is:

- `true` when the values are **not equivalent**.
- `false` when the values are **equivalent**.

$not (aggregation)

$not
Returns the boolean opposite value passed to it. When passed a `true` value, `$not` (page 732) returns `false`; when passed a `false` value, `$not` (page 732) returns `true`.

$or (aggregation)

$or

Takes an array of one or more values and returns `true` if *any* of the values in the array are `true`. Otherwise `$or` (page 733) returns false.

Note: `$or` (page 733) uses short-circuit logic: the operation stops evaluation after encountering the first `true` expression.

$project (aggregation)

$project

Reshapes a document stream by renaming, adding, or removing fields. Also use `$project` (page 733) to create computed values or sub-objects. Use `$project` (page 733) to:

- Include fields from the original document.
- Insert computed fields.
- Rename fields.
- Create and populate fields that hold sub-documents.

Use `$project` (page 733) to quickly select the fields that you want to include or exclude from the response. Consider the following aggregation framework operation.

```
db.article.aggregate(
    { $project : {
        title : 1 ,
        author : 1 ,
    }}
 );
```

This operation includes the `title` field and the `author` field in the document that returns from the aggregation *pipeline*.

Note: The `_id` field is always included by default. You may explicitly exclude `_id` as follows:

```
db.article.aggregate(
    { $project : {
        _id : 0 ,
        title : 1 ,
        author : 1
    }}
);
```

Here, the projection excludes the `_id` field but includes the `title` and `author` fields.

Projections can also add computed fields to the document stream passing through the pipeline. A computed field can use any of the *expression operators* (page 218). Consider the following example:

```
db.article.aggregate(
    { $project : {
        title : 1,
        doctoredPageViews : { $add:["$pageViews", 10] }
    }}
);
```

Here, the field `doctoredPageViews` represents the value of the `pageViews` field after adding 10 to the original field using the `$add` (page 727).

Note: You must enclose the expression that defines the computed field in braces, so that the expression is a valid object.

You may also use `$project` (page 733) to rename fields. Consider the following example:

```
db.article.aggregate(
    { $project : {
        title : 1 ,
        page_views : "$pageViews" ,
        bar : "$other.foo"
    }}
);
```

This operation renames the `pageViews` field to `page_views`, and renames the `foo` field in the `other` sub-document as the top-level field `bar`. The field references used for renaming fields are direct expressions and do not use an operator or surrounding braces. All aggregation field references can use dotted paths to refer to fields in nested documents.

Finally, you can use the `$project` (page 733) to create and populate new sub-documents. Consider the following example that creates a new object-valued field named `stats` that holds a number of values:

```
db.article.aggregate(
    { $project : {
        title : 1 ,
        stats : {
            pv : "$pageViews",
            foo : "$other.foo",
            dpv : { $add:["$pageViews", 10] }
        }
    }}
);
```

This projection includes the `title` field and places `$project` (page 733) into "inclusive" mode. Then, it creates the `stats` documents with the following fields:

- `pv` which includes and renames the `pageViews` from the top level of the original documents.
- `foo` which includes the value of `other.foo` from the original documents.
- `dpv` which is a computed field that adds 10 to the value of the `pageViews` field in the original document using the `$add` (page 727) aggregation expression.

$push (aggregation)

$push

Returns an array of all the values found in the selected field among the documents in that group. *A value may appear more than once* in the result set if more than one field in the grouped documents has that value.

$second (aggregation)

$second

Takes a date and returns the second between 0 and 59, but can be 60 to account for leap seconds.

$skip (aggregation)

$skip

Skips over the specified number of *documents* that pass through the $skip (page 735) in the *pipeline* before passing all of the remaining input.

$skip (page 735) takes a single numeric (positive whole number) value as a parameter. Once the operation has skipped the specified number of documents, it passes all the remaining documents along the *pipeline* without alteration. Consider the following example:

```
db.article.aggregate(
    { $skip : 5 }
);
```

This operation skips the first 5 documents passed to it by the pipeline. $skip (page 735) has no effect on the content of the documents it passes along the pipeline.

$sort (aggregation)

$sort

The $sort (page 735) *pipeline* operator sorts all input documents and returns them to the pipeline in sorted order. Consider the following prototype form:

```
db.<collection-name>.aggregate(
    { $sort : { <sort-key> } }
);
```

This sorts the documents in the collection named <collection-name>, according to the key and specification in the { <sort-key> } document.

Specify the sort in a document with a field or fields that you want to sort by and a value of 1 or -1 to specify an ascending or descending sort respectively, as in the following example:

```
db.users.aggregate(
    { $sort : { age : -1, posts: 1 } }
);
```

This operation sorts the documents in the users collection, in descending order according by the age field and then in ascending order according to the value in the posts field.

When comparing values of different *BSON* types, MongoDB uses the following comparison order, from lowest to highest:

1. MinKey (internal type)
2. Null
3. Numbers (ints, longs, doubles)
4. Symbol, String
5. Object
6. Array
7. BinData
8. ObjectID
9. Boolean
10. Date, Timestamp

11.Regular Expression

12.MaxKey (internal type)

Note: MongoDB treats some types as equivalent for comparison purposes. For instance, numeric types undergo conversion before comparison.

Note: The $sort (page 735) cannot begin sorting documents until previous operators in the pipeline have returned all output.

–$skip (page 735)

$sort (page 735) operator can take advantage of an index when placed at the **beginning** of the pipeline or placed **before** the following aggregation operators:

–$project (page 733)

–$unwind (page 737)

–$group (page 728).

Warning: Unless the $sort (page 735) operator can use an index, in the current release, the sort must fit within memory. This may cause problems when sorting large numbers of documents.

$strcasecmp (aggregation)

$strcasecmp

Takes in two strings. Returns a number. $strcasecmp (page 736) is positive if the first string is "greater than" the second and negative if the first string is "less than" the second. $strcasecmp (page 736) returns 0 if the strings are identical.

Note: $strcasecmp (page 736) may not make sense when applied to glyphs outside the Roman alphabet.

$strcasecmp (page 736) internally capitalizes strings before comparing them to provide a case-*insensitive* comparison. Use $cmp (page 727) for a case sensitive comparison.

$substr (aggregation)

$substr

$substr (page 736) takes a string and two numbers. The first number represents the number of bytes in the string to skip, and the second number specifies the number of bytes to return from the string.

Note: $substr (page 736) is not encoding aware and if used improperly may produce a result string containing an invalid UTF-8 character sequence.

$subtract (aggregation)

$subtract

Takes an array that contains a pair of numbers and subtracts the second from the first, returning their

difference.

$sum (aggregation)

$sum

Returns the sum of all the values for a specified field in the grouped documents, as in the second use above.

Alternately, if you specify a value as an argument, `$sum` (page 737) will increment this field by the specified value for every document in the grouping. Typically, as in the first use above, specify a value of `1` in order to count members of the group.

$toLower (aggregation)

$toLower

Takes a single string and converts that string to lowercase, returning the result. All uppercase letters become lowercase.

Note: `$toLower` (page 737) may not make sense when applied to glyphs outside the Roman alphabet.

$toUpper (aggregation)

$toUpper

Takes a single string and converts that string to uppercase, returning the result. All lowercase letters become uppercase.

Note: `$toUpper` (page 737) may not make sense when applied to glyphs outside the Roman alphabet.

$unwind (aggregation)

$unwind

Peels off the elements of an array individually, and returns a stream of documents. `$unwind` (page 737) returns one document for every member of the unwound array within every source document. Take the following aggregation command:

```
db.article.aggregate(
    { $project : {
        author : 1 ,
        title : 1 ,
        tags : 1
    }},
    { $unwind : "$tags" }
);
```

Note: The dollar sign (i.e. `$`) must proceed the field specification handed to the `$unwind` (page 737) operator.

In the above aggregation `$project` (page 733) selects (inclusively) the `author`, `title`, and `tags` fields, as well as the `_id` field implicitly. Then the pipeline passes the results of the projection to the `$unwind` (page 737) operator, which will unwind the `tags` field. This operation may return a sequence

of documents that resemble the following for a collection that contains one document holding a `tags` field with an array of 3 items.

```
{
     "result" : [
              {
                       "_id" : ObjectId("4e6e4ef557b77501a49233f6"),
                       "title" : "this is my title",
                       "author" : "bob",
                       "tags" : "fun"
              },
              {
                       "_id" : ObjectId("4e6e4ef557b77501a49233f6"),
                       "title" : "this is my title",
                       "author" : "bob",
                       "tags" : "good"
              },
              {
                       "_id" : ObjectId("4e6e4ef557b77501a49233f6"),
                       "title" : "this is my title",
                       "author" : "bob",
                       "tags" : "fun"
              }
     ],
     "OK" : 1
}
```

A single document becomes 3 documents: each document is identical except for the value of the `tags` field. Each value of `tags` is one of the values in the original "tags" array.

Note: `$unwind` (page 737) has the following behaviors:

- `$unwind` (page 737) is most useful in combination with `$group` (page 728).
- You may undo the effects of unwind operation with the `$group` (page 728) pipeline operator.
- If you specify a target field for `$unwind` (page 737) that does not exist in an input document, the pipeline ignores the input document, and will generate no result documents.
- If you specify a target field for `$unwind` (page 737) that is not an array, `db.collection.aggregate()` (page 815) generates an error.
- If you specify a target field for `$unwind` (page 737) that holds an empty array (`[]`) in an input document, the pipeline ignores the input document, and will generates no result documents.

$week (aggregation)

`$week`

Takes a date and returns the week of the year as a number between 0 and 53.

Weeks begin on Sundays, and week 1 begins with the first Sunday of the year. Days preceding the first Sunday of the year are in week 0. This behavior is the same as the "`%U`" operator to the `strftime` standard library function.

$year (aggregation)

$year
Takes a date and returns the full year.

61.1.2 Database Commands

addShard

addShard

Parameters

- **hostname** (*string*) – a hostname or replica-set/hostname string.
- **name** (*string*) – Optional. Unless specified, a name will be automatically provided to uniquely identify the shard.
- **maxSize** (*integer*) – Optional, megabytes. Limits the maximum size of a shard. If `maxSize` is `0` then MongoDB will not limit the size of the shard.

Use the `addShard` (page 739) command to add a database instance or replica set to a *sharded cluster*. You must run this command when connected a `mongos` (page 905) instance.

The command takes the following form:

```
{ addShard: "<hostname><:port>" }
```

Example

```
db.runCommand({addShard: "mongodb0.example.net:27027"})
```

Replace `<hostname><:port>` with the hostname and port of the database instance you want to add as a shard.

> **Warning:** Do not use `localhost` for the hostname unless your *configuration server* is also running on `localhost`.

The optimal configuration is to deploy shards across *replica sets*. To add a shard on a replica set you must specify the name of the replica set and the hostname of at least one member of the replica set. You must specify at least one member of the set, but can specify all members in the set or another subset if desired. `addShard` (page 739) takes the following form:

```
{ addShard: "replica-set/hostname:port" }
```

Example

```
db.runCommand( { addShard: "repl0/mongodb3.example.net:27327"} )
```

If you specify additional hostnames, all must be members of the same replica set.

Send this command to only one `mongos` (page 905) instance, it will store shard configuration information in the *config database*.

Note: Specify a `maxSize` when you have machines with different disk capacities, or if you want to limit the amount of data on some shards.

The `maxSize` constraint prevents the *balancer* from migrating chunks to the shard when the value of `mem.mapped` (page 970) exceeds the value of `maxSize`.

See Also:

- `sh.addShard()` (page 864)
- *Sharded Cluster Administration* (page 368)
- *Add Shards to a Cluster* (page 387)
- *Remove Shards from an Existing Sharded Cluster* (page 400)

aggregate

aggregate

New in version 2.1.0. `aggregate` (page 740) implements the *aggregation framework*. Consider the following prototype form:

```
{ aggregate: "[collection]", pipeline: [pipeline] }
```

Where `[collection]` specifies the name of the collection that contains the data that you wish to aggregate. The `pipeline` argument holds an array that contains the specification for the aggregation operation. Consider the following example from the *aggregation documentation* (page 195).

```
db.runCommand(
{ aggregate : "article", pipeline : [
  { $project : {
     author : 1,
     tags : 1,
  } },
  { $unwind : "$tags" },
  { $group : {
     _id : "$tags",
     authors : { $addToSet : "$author" }
  } }
 ] }
);
```

More typically this operation would use the `aggregate()` (page 815) helper in the `mongo` (page 908) shell, and would resemble the following:

```
db.article.aggregate(
  { $project : {
     author : 1,
     tags : 1,
  } },
  { $unwind : "$tags" },
  { $group : {
     _id : "$tags",
     authors : { $addToSet : "$author" }
  } }
);
```

For more aggregation documentation, please see:

- *Aggregation Framework* (page 195)
- *Aggregation Framework Reference* (page 211)
- *Aggregation Framework Examples* (page 201)

applyOps (internal)

applyOps

Parameters

- **operations** (*array*) – an array of operations to perform.
- **preCondition** (*array*) – Optional. Defines one or more conditions that the destination must meet applying the entries from the `<operations>` array. Use `ns` to specify a *namespace*, `q` to specify a *query* and `res` to specify the result that the query should match. You may specify zero, one, or many `preCondition` documents.

`applyOps` (page 741) provides a way to apply entries from an *oplog* created by *replica set* members and *master* instances in a master/*slave* deployment. `applyOps` (page 741) is primarily an internal command to support sharding functionality, and has the following prototype form:

```
db.runCommand( { applyOps: [ <operations> ], preCondition: [ { ns: <namespace>, q: <query>, res:
```

`applyOps` (page 741) applies oplog entries from the `<operations>` array, to the `mongod` (page 897) instance. The `preCondition` array provides the ability to specify conditions that must be true in order to apply the oplog entry.

You can specify as many `preCondition` sets as needed. If you specify the `ns` option, `applyOps` (page 741) will only apply oplog entries for the *collection* described by that namespace. You may also specify a query in the `q` field with a corresponding expected result in the `res` field that must match in order to apply the oplog entry.

Warning: This command obtains a global write lock and will block other operations until it has completed.

authenticate

authenticate

Clients use `authenticate` (page 741) to authenticate a connection. When using the shell, use the `db.auth()` (page 814) helper as follows:

```
db.auth( "username", "password" )
```

See Also:

`db.auth()` (page 814) and *Security Practices and Management* (page 87) for more information.

availableQueryOptions (internal)

availableQueryOptions

`availableQueryOptions` (page 741) is an internal command that is only available on `mongos` (page 905) instances.

buildInfo

buildInfo

The buildInfo (page 742) command is an administrative command which returns a build summary for the current mongod (page 897).

```
{ buildInfo: 1 }
```

The information provided includes the following:

- The version of MongoDB currently running.
- The information about the system that built the "mongod (page 897)" binary, including a timestamp for the build.
- The architecture of the binary (i.e. 64 or 32 bits.)
- The maximum allowable *BSON* object size in bytes (in the field maxBsonObjectSize.)

captrunc (internal)

captrunc

The captrunc (page 742) command is an internal command that truncates capped collections.

Parameters

- **collection** (*string*) – The name of the collection to truncate.
- **n** (*integer*) – An integer that specifies the number of documents to remove from the collection
- **inc** (*boolean*) – Specifies whether to truncate the nth document.

Example

Truncate 10 older documents from the collection records:

```
db.runCommand({captrunc: "records" , n:10})
```

Truncate 100 documents and the 101st document:

```
db.runCommand({captrunc: "records", n:100, inc:true})
```

---

checkShardingIndex (internal)

checkShardingIndex

checkShardingIndex (page 742) is an internal command that supports the sharding functionality.

clean (internal)

clean

clean (page 742) is an internal command.

Warning: This command obtains a write lock on the affected database and will block other operations until it has completed.

clone

clone

The clone (page 743) command clone a database from a remote MongoDB instance to the current host. clone (page 743) copies the database on the remote instance with the same name as the current database. The command takes the following form:

```
{ clone: "db1.example.net:27017" }
```

Replace db1.example.net:27017 above with the resolvable hostname for the MongoDB instance you wish to copy from. Note the following behaviors:

- clone (page 743) can run against a *slave* or a non-*primary* member of a *replica set*.
- clone (page 743) does not snapshot the database. If any clients update the database you're copying at any point during the clone operation, the resulting database may be inconsistent.
- You must run clone (page 743) on the **destination server**.
- The destination server is not locked for the duration of the clone (page 743) operation. This means that clone (page 743) will occasionally yield to allow other operations to complete.

See copydb (page 749) for similar functionality.

Warning: This command obtains an intermittent write-lock on the destination server, that can block other operations until it completes.

cloneCollection

cloneCollection

The cloneCollection (page 743) command copies a collection from a remote server to the server where you run the command. cloneCollection (page 743) does not allow you to clone a collection through a mongos (page 905): you must connect directly to the mongod (page 897) instance.

Parameters

- **from** – Specify a resolvable hostname, and optional port number of the remote server where the specified collection resides.
- **query** – Optional. A query document, in the form of a *document*, that filters the documents in the remote collection that cloneCollection (page 743) will copy to the current database. See db.collection.find() (page 820).
- **copyIndexes** (*Boolean*) – Optional. true by default. When set to false the indexes on the originating server are *not* copied with the documents in the collection.

Consider the following example:

```
{ cloneCollection: "users.profiles", from: "mongodb.example.net:27017", query: { active: true },
```

This operation copies the profiles collection from the users database on the server at mongodb.example.net. The operation only copies documents that satisfy the query { active: true } and does not copy indexes. cloneCollection (page 743) copies indexes by default, but you can disable this behavior by setting { copyIndexes: false }. The query and copyIndexes arguments are optional.

cloneCollection (page 743) creates a collection on the current database with the same name as the origin collection. If, in the above example, the profiles collection already exists in the local database, then MongoDB appends documents in the remote collection to the destination collection.

cloneCollectionAsCapped

cloneCollectionAsCapped

The `cloneCollectionAsCapped` (page 744) command creates a new *capped collection* from an existing, non-capped collection within the same database. The operation does not affect the original non-capped collection.

The command has the following syntax:

```
{ cloneCollectionAsCapped: <existing collection>, toCollection: <capped collection>, size: <capp
```

The command copies an `existing collection` and creates a new `capped collection` with a maximum size specified by the `capped size` in bytes. The name of the new capped collection must be distinct and cannot be the same as that of the original existing collection. To replace the original non-capped collection with a capped collection, use the `convertToCapped` (page 748) command.

During the cloning, the `cloneCollectionAsCapped` (page 744) command exhibit the following behavior:

- MongoDB will transverse the documents in the original collection in *natural order* as they're loaded.
- If the `capped size` specified for the new collection is smaller than the size of the original uncapped collection, then MongoDB will begin overwriting earlier documents in insertion order, which is *first in, first out* (e.g "FIFO").

closeAllDatabases (internal)

closeAllDatabases

`closeAllDatabases` (page 744) is an internal command that invalidates all cursors and closes the open database files. The next operation that uses the database will reopen the file.

> **Warning:** This command obtains a global write lock and will block other operations until it has completed.

collMod

collMod

New in version 2.2. `collMod` (page 744) makes it possible to add flags to a collection to modify the behavior of MongoDB. In the current release the only available flag is `usePowerOf2Sizes` (page 744). The command takes the following prototype form:

```
db.runCommand( {"collMod" : <collection> , "<flag>" : <value> } )
```

In this command substitute `<collection>` with the name of a collection in the current database, and `<flag>` and `<value>` with the flag and value you want to set.

usePowerOf2Sizes

The `usePowerOf2Sizes` (page 744) flag changes the method that MongoDB uses to allocate space on disk for documents in this collection. By setting `usePowerOf2Sizes` (page 744), you ensure that MongoDB will allocate space for documents in sizes that are powers of 2 (e.g. 4, 8, 16, 32, 64, 128, 256, 512...8388608). With `usePowerOf2Sizes` (page 744) MongoDB will be able to more effectively reuse space.

`usePowerOf2Sizes` (page 744) is useful for collections where you will be inserting and deleting large numbers of documents to ensure that MongoDB will effectively use space on disk.

Example

To enable `usePowerOf2Sizes` (page 744) on the collection named `products`, use the following operation:

```
db.runCommand( {collMod: "products", usePowerOf2Sizes : true })
```

To disable `usePowerOf2Sizes` (page 744) on the collection `products`, use the following operation:

```
db.runCommand( { collMod: "products", "usePowerOf2Sizes": false })
```

Warning: Changed in version 2.2.1: `usePowerOf2Sizes` (page 744) now supports documents larger than 8 megabytes. If you enable `usePowerOf2Sizes` (page 744) you **must** use at least version 2.2.1. `usePowerOf2Sizes` (page 744) only affects subsequent allocations caused by document insertion or record relocation as a result of document growth, and *does not* affect existing allocations.

Note: `usePowerOf2Sizes` (page 744) has no effect on *capped collections*.

collStats

collStats

The `collStats` (page 745) command returns a variety of storage statistics for a given collection. Use the following syntax:

```
{ collStats: "collection" , scale : 1024 }
```

Specify the `collection` you want statistics for, and use the `scale` argument to scale the output. The above example will display values in kilobytes.

Examine the following example output, which uses the `db.collection.stats()` (page 841) helper in the `mongo` (page 908) shell.

```
> db.users.stats()
{
        "ns" : "app.users",                 // namespace
        "count" : 9,                        // number of documents
        "size" : 432,                       // collection size in bytes
        "avgObjSize" : 48,                  // average object size in bytes
        "storageSize" : 3840,               // (pre)allocated space for the collection
        "numExtents" : 1,                   // number of extents (contiguously allocated chunks of d
        "nindexes" : 2,                     // number of indexes
        "lastExtentSize" : 3840,            // size of the most recently created extent
        "paddingFactor" : 1,                // padding can speed up updates if documents grow
        "flags" : 1,
        "totalIndexSize" : 16384,           // total index size in bytes
        "indexSizes" : {                    // size of specific indexes in bytes
                "_id_" : 8192,
                "username" : 8192
        },
        "ok" : 1
}
```

Note: The scale factor rounds values to whole numbers. This can produce unpredictable and unexpected results in some situations.

See Also:

"*Collection Statistics Reference* (page 980)."

compact

compact

New in version 2.0. The `compact` (page 746) command rewrites and defragments a single collection. Additionally, the command drops all indexes at the beginning of compaction and rebuilds the indexes at the end. `compact` (page 746) is conceptually similar to `repairDatabase` (page 787), but works on a single collection rather than an entire database.

The command has the following syntax:

```
{ compact: <collection name> }
```

You may also specify the following options:

Parameters

- **force** – Changed in version 2.2: `compact` (page 746) blocks activities only for the database it is compacting. The `force` specifies whether the `compact` (page 746) command can run on the primary node in a *replica set*. Set to `true` to run the `compact` (page 746) command on the primary node in a *replica set*. Otherwise, the `compact` (page 746) command returns an error when invoked on a *replica set* primary because the command blocks all other activity.
- **paddingFactor** – New in version 2.2. *Default:* `1.0`

  Minimum: `1.0` (no padding.)

  Maximum: `4.0`

  The `paddingFactor` describes the *record size* allocated for each document as a factor of the document size, for all records compacted during the `compact` (page 746) operation. `paddingFactor` does not affect the padding of subsequent record allocations after `compact` (page 746) completes.

  If your updates increase the size of the documents, padding will increase the amount of space allocated to each document and avoid expensive document relocation operations within the data files.

  You can calculate the padding size by subtracting the document size from the record size or, in terms of the `paddingFactor`, by subtracting `1` from the `paddingFactor`:

  ```
  padding size = (paddingFactor - 1) * <document size>.
  ```

  For example, a `paddingFactor` of `1.0` specifies a padding size of `0` whereas a `paddingFactor` of `1.2` specifies a padding size of `0.2` or 20 percent (20%) of the document size.

  With the following command, you can use the `paddingFactor` option of the `compact` (page 746) command to set the record size to `1.1` of the document size, or a padding factor of 10 percent (10%):

  ```
  db.runCommand ( { compact: '<collection>', paddingFactor: 1.1 } )
  ```

  `compact` (page 746) compacts existing documents, but does not reset `paddingFactor` statistics for the collection. After the `compact` (page 746) MongoDB will use the existing `paddingFactor` when allocating new records for documents in this collection.

- **paddingBytes** – New in version 2.2. The `paddingBytes` sets the padding as an absolute number of bytes, for all records compacted during the `compact` (page 746) operation. After running `compact` (page 746), `paddingBytes` does not affect the padding of subsequent record allocations.

  Specifying `paddingBytes` can be useful if your documents start small but then increase in size significantly. For example,if your documents are initially 40 bytes long and you grow them by 1KB, using `paddingBytes: 1024` might be reasonable since using `paddingFactor: 4.0` would specify a record size of 160 bytes (`4.0` times the initial document size), which would only provide a padding of 120 bytes (i.e. record size of 160 bytes minus the document size).

  With the following command, you can use the `paddingBytes` option of the `compact` (page 746) command to set the padding size to `100` bytes on the collection named by `<collection>`:

  ```
  db.runCommand ( { compact: '<collection>', paddingBytes: 100 } )
  ```

Warning: Always have an up-to-date backup before performing server maintenance such as the `compact` (page 746) operation.

Note the following behaviors:

- `compact` (page 746) blocks all other activity. In MongoDB 2.2, `compact` (page 746) blocks activities only for its database. You may view the intermediate progress either by viewing the `mongod` (page 897) log file, or by running the `db.currentOp()` (page 846) in another shell instance.
- `compact` (page 746) compacts existing documents in the collection. However, unlike `repairDatabase` (page 787), `compact` (page 746) does not reset `paddingFactor` statistics for the collection. MongoDB will use the existing `paddingFactor` when allocating new records for documents in this collection.
- `compact` (page 746) generally uses less disk space than `repairDatabase` (page 787) and is faster. However,the `compact` (page 746) command is still slow and does block other database use. Only use `compact` (page 746) during scheduled maintenance periods.
- If you terminate the operation with the `db.killOp()` (page 851) method or restart the server before it has finished:
  - If you have journaling enabled, the data remains consistent and usable, regardless of the state of the `compact` (page 746) operation. You may have to manually rebuild the indexes.
  - If you do not have journaling enabled and the `mongod` (page 897) or `compact` (page 746) terminates during the operation, it's impossible to guarantee that the data is in a consistent state.
  - In either case, much of the existing free space in the collection may become un-reusable. In this scenario, you should rerun the compaction to completion to restore the use of this free space.
- `compact` (page 746) may increase the total size and number of our data files, especially when run for the first time. However, this will not increase the total collection storage space since storage size is the amount of data allocated within the database files, and not the size/number of the files on the file system.
- `compact` (page 746) requires a small amount of additional disk space while running but unlike `repairDatabase` (page 787) it does *not* free space on the file system.
- You may also wish to run the `collStats` (page 745) command before and after compaction to see how the storage space changes for the collection.
- `compact` (page 746) commands do not replicate to secondaries in a *replica set*:

–Compact each member separately.

–Ideally, compaction runs on a secondary. See option `force:true` above for information regarding compacting the primary.

> **Warning:** If you run `compact` (page 746) on a secondary, the secondary will enter a `RECOVERING` state to prevent clients from sending read operations during compaction. Once the operation finishes the secondary will automatically return to `SECONDARY` state. See `state` (page 988) for more information replica set member states. Refer to the "partial script for automating step down and compaction" for an example of this procedure.

- `compact` (page 746) is a command issued to a `mongod` (page 897). In a sharded environment, run `compact` (page 746) on each shard separately as a maintenance operation.

Important: You cannot issue `compact` (page 746) against a `mongos` (page 905) instance.

- It is not possible to compact *capped collections* because they don't have padding, and documents cannot grow in these collections. However, the documents of a *capped collections* are not subject to fragmentation.

See Also:

`repairDatabase` (page 787)

connPoolStats

connPoolStats

Note: `connPoolStats` (page 748) only returns meaningful results for `mongos` (page 905) instances and for `mongod` (page 897) instances in sharded clusters.

The command `connPoolStats` (page 748) returns information regarding the number of open connections to the current database instance, including client connections and server-to-server connections for replication and clustering. The command takes the following form:

```
{ connPoolStats: 1 }
```

The value of the argument (i.e. `1`) does not affect the output of the command. See *Connection Pool Statistics Reference* (page 985) for full documentation of the `connPoolStats` (page 748) output.

connPoolSync (internal)

connPoolSync

`connPoolSync` (page 748) is an internal command.

convertToCapped

convertToCapped

The `convertToCapped` (page 748) command converts an existing, non-capped collection to a *capped collection* within the same database.

The command has the following syntax:

```
{convertToCapped: <collection>, size: <capped size> }
```

convertToCapped (page 748) takes an existing collection (<collection>) and transforms it into a capped collection with a maximum size in bytes, specified to the size argument (<capped size>).

During the conversion process, the convertToCapped (page 748) command exhibit the following behavior:

- MongoDB transverses the documents in the original collection in *natural order* and loads the documents into a new capped collection.
- If the capped size specified for the capped collection is smaller than the size of the original uncapped collection, then MongoDB will overwrite documents in the capped collection based on insertion order, or *first in, first out* order.
- Internally, to convert the collection, MongoDB uses the following procedure
  - cloneCollectionAsCapped (page 744) command creates the capped collection and imports the data.
  - MongoDB drops the original collection.
  - renameCollection (page 786) renames the new capped collection to the name of the original collection.

Note: MongoDB does not support the convertToCapped (page 748) command in a sharded cluster.

Warning: The convertToCapped (page 748) will not recreate indexes from the original collection on the new collection, other than the index on the _id field. If you need indexes on this collection you will need to create these indexes after the conversion is complete.

See Also:

create (page 751)

Warning: This command obtains a global write lock and will block other operations until it has completed.

copydb

copydb

The copydb (page 749) command copies a database from a remote host to the current host. The command has the following syntax:

```
{ copydb: 1:
  fromhost: <hostname>,
  fromdb: <db>,
  todb: <db>,
  slaveOk: <bool>,
  username: <username>,
  password: <password>,
  nonce: <nonce>,
  key: <key> }
```

All of the following arguments are optional:

- slaveOk
- username

- password
- nonce
- key

You can omit the `fromhost` argument, to copy one database to another database within a single MongoDB instance.

You must run this command on the destination, or the `todb` server.

Be aware of the following behaviors:

- `copydb` (page 749) can run against a *slave* or a non-*primary* member of a *replica set*. In this case, you must set the `slaveOk` option to `true`.
- `copydb` (page 749) does not snapshot the database. If the state of the database changes at any point during the operation, the resulting database may be inconsistent.
- You must run `copydb` (page 749) on the **destination server**.
- The destination server is not locked for the duration of the `copydb` (page 749) operation. This means that `copydb` (page 749) will occasionally yield to allow other operations to complete.
- If the remote server has authentication enabled, then you must include a username and password. You must also include a nonce and a key. The nonce is a one-time password that you request from the remote server using the `copydbgetnonce` (page 750) command. The `key` is a hash generated as follows:

```
hex_md5(nonce + username + hex_md5(username + ":mongo:" + pass))
```

If you need to copy a database and authenticate, it's easiest to use the shell helper:

```
db.copyDatabase(<remote_db_name>, <local_db_name>, <from_host_name>, <username>, <password>)
```

copydbgetnonce (internal)

copydbgetnonce

Client libraries use `copydbgetnonce` (page 750) to get a one-time password for use with the `copydb` (page 749) command.

Note: This command obtains a write lock on the affected database and will block other operations until it has completed; however, the write lock for this operation is short lived.

---

count

count

The `count` (page 750) command counts the number of documents in a collection. The command returns a document that contains the count as well as the command status. The `count` (page 750) command takes the following prototype form:

```
{ count: <collection>, query: <query>, limit: <limit>, skip: <skip> }
```

The command fields are as follows:

Fields

- **count** (*String*) – The name of the collection to count.

- **query** (*document*) – Optional. Specifies the selection query to determine which documents in the collection to count.
- **limit** (*integer*) – Optional. Specifies the limit for the documents matching the selection `query`.
- **skip** (*integer*) – Optional. Specifies the number of matching documents to skip.

Consider the following examples of the `count` (page 750) command:

•Count the number of all documents in the `orders` collection:

```
db.runCommand( { count: 'orders' } )
```

In the result, the `n`, which represents the count, is `26` and the command status `ok` is `1`:

```
{ "n" : 26, "ok" : 1 }
```

•Count the number of the documents in the `orders` collection with the field `ord_dt` greater than `new Date('01/01/2012')`:

```
db.runCommand( { count:'orders',
                 query: { ord_dt: { $gt: new Date('01/01/2012') } }
               } )
```

In the result, the `n`, which represents the count, is `13` and the command status `ok` is `1`:

```
{ "n" : 13, "ok" : 1 }
```

•Count the number of the documents in the `orders` collection with the field `ord_dt` greater than `new Date('01/01/2012')` skipping the first `10` matching records:

```
db.runCommand( { count:'orders',
                 query: { ord_dt: { $gt: new Date('01/01/2012') } },
                 skip: 10 } )
```

In the result, the `n`, which represents the count, is `3` and the command status `ok` is `1`:

```
{ "n" : 3, "ok" : 1 }
```

Note: MongoDB also provides the `cursor.count()` (page 804) method and the shell wrapper `db.collection.count()` (page 816) method.

---

create

create

The `create` command explicitly creates a collection. The command uses the following syntax:

```
{ create: <collection_name> }
```

To create a *capped collection* limited to 40 KB, issue command in the following form:

```
{ create: "collection", capped: true, size: 40 * 1024 }
```

The options for creating capped collections are:

Options

- **capped** – Specify `true` to create a *capped collection*.

- **autoIndexId** – Specify `false` to disable the automatic index created on the `_id` field. Before 2.2, the default value for `autoIndexId` was `false`. See *_id Fields and Indexes on Capped Collections* (page 1042) for more information.
- **size** – The maximum size for the capped collection. Once a capped collection reaches its max size, MongoDB will drop old documents from the database to make way for the new documents. You must specify a `size` argument for all capped collections.
- **max** – The maximum number of documents to preserve in the capped collection. This limit is subject to the overall size of the capped collection. If a capped collection reaches its maximum size before it contains the maximum number of documents, the database will remove old documents. Thus, if you use this option, ensure that the total size for the capped collection is sufficient to contain the max.

The `db.createCollection()` (page 845) provides a wrapper function that provides access to this functionality.

Note: This command obtains a write lock on the affected database and will block other operations until it has completed. The write lock for this operation is typically short lived; however, allocations for large capped collections may take longer.

---

cursorInfo

cursorInfo

The `cursorInfo` (page 752) command returns information about current cursor allotment and use. Use the following form:

```
{ cursorInfo: 1 }
```

The value (e.g. `1` above,) does not affect the output of the command.

`cursorInfo` (page 752) returns the total number of open cursors (`totalOpen`,) the size of client cursors in current use (`clientCursors_size`,) and the number of timed out cursors since the last server restart (`timedOut`.)

dataSize

dataSize

For internal use.

The `dataSize` (page 752) command returns the size data size for a set of data within a certain range:

```
{ dataSize: "database.collection", keyPattern: { field: 1 }, min: { field: 10 }, max: { field: 1
```

This will return a document that contains the size of all matching documents. Replace `database.collection` value with database and collection from your deployment. The `keyPattern`, `min`, and `max` parameters are options.

The amount of time required to return `dataSize` (page 752) depends on the amount of data in the collection.

dbHash (internal)

dbHash

`dbHash` (page 752) is an internal command.

dbStats

dbStats

The dbStats (page 753) command returns storage statistics for a given database. The command takes the following syntax:

```
{ dbStats: 1, scale: 1 }
```

The value of the argument (e.g. 1 above) to dbStats does not affect the output of the command. The scale option allows you to specify how to scale byte values. For example, a scale value of 1024 will display the results in kilobytes rather than in bytes.

The time required to run the command depends on the total size of the database. Because the command has to touch all data files, the command may take several seconds to run.

In the mongo (page 908) shell, the db.stats() (page 855) function provides a wrapper around this functionality. See the "*Database Statistics Reference* (page 979)" document for an overview of this output.

diagLogging (internal)

diagLogging

diagLogging (page 753) is an internal command.

Warning: This command obtains a write lock on the affected database and will block other operations until it has completed.

distinct

distinct

The distinct (page 753) command finds the distinct values for a specified field across a single collection. The command returns a document that contains an array of the distinct values as well as the query plan and status. The command takes the following prototype form:

```
{ distinct: collection, key: <field>, query: <query> }
```

The command fields are as follows:

Fields

- **collection** (*String*) – The name of the collection to query for distinct values.
- **field** (*string*) – Specifies the field for which to return the distinct values.
- **query** (*document*) – Optional. Specifies the selection query to determine the subset of documents from which to retrieve the distinct values.

Consider the following examples of the distinct (page 753) command:

•Return an array of the distinct values of the field ord_dt from all documents in the orders collection:

```
db.runCommand ( { distinct: 'orders', key: 'ord_dt' } )
```

•Return an array of the distinct values of the field sku in the subdocument item from all documents in the orders collection:

```
db.runCommand ( { distinct: 'orders', key: 'item.sku' } )
```

- Return an array of the distinct values of the field `ord_dt` from the documents in the `orders` collection where the `price` is greater than `10`:

```
db.runCommand ( { distinct: 'orders',
                  key: 'ord_dt',
                  query: { price: { $gt: 10 } }
                } )
```

Note:

- MongoDB also provides the shell wrapper method `db.collection.distinct()` (page 817) for the `distinct` (page 753) command. Additionally, many MongoDB *drivers* also provide a wrapper method. Refer to the specific driver documentation.
- When possible, the `distinct` (page 753) command will use an index to find the documents in the query as well as to return the data.

---

driverOIDTest (internal)

driverOIDTest

`driverOIDTest` (page 754) is an internal command.

drop

drop

The `drop` (page 754) command removes an entire collection from a database. The command has following syntax:

```
{ drop: <collection_name> }
```

The `mongo` (page 908) shell provides the equivalent helper method:

```
db.collection.drop();
```

Note that this command also removes any indexes associated with the dropped collection.

Warning: This command obtains a write lock on the affected database and will block other operations until it has completed.

dropDatabase

dropDatabase

The `dropDatabase` (page 754) command drops a database, deleting the associated data files. `dropDatabase` (page 754) operates on the current database.

In the shell issue the `use <database>` command, replacing `<database>` with the name of the database you wish to delete. Then use the following command form:

```
{ dropDatabase: 1 }
```

The `mongo` (page 908) shell also provides the following equivalent helper method:

```
db.dropDatabase();
```

> **Warning:** This command obtains a global write lock and will block other operations until it has completed.

dropIndexes

dropIndexes

The dropIndexes (page 755) command drops one or all indexes from the current collection. To drop all indexes, issue the command like so:

```
{ dropIndexes: "collection", index: "*" }
```

To drop a single, issue the command by specifying the name of the index you want to drop. For example, to drop the index named age_1, use the following command:

```
{ dropIndexes: "collection", index: "age_1" }
```

The shell provides a useful command helper. Here's the equivalent command:

```
db.collection.dropIndex("age_1");
```

> **Warning:** This command obtains a write lock on the affected database and will block other operations until it has completed.

emptycapped

emptycapped

The emptycapped command removes all documents from a capped collection. Use the following syntax:

```
{ emptycapped: "events" }
```

This command removes all records from the capped collection named events.

> **Warning:** This command obtains a write lock on the affected database and will block other operations until it has completed.

enableSharding

enableSharding

The enableSharding (page 755) command enables sharding on a per-database level. Use the following command form:

```
{ enableSharding: "<database name>" }
```

Once you've enabled sharding in a database, you can use the shardCollection (page 794) command to begin the process of distributing data among the shards.

eval

eval

The eval (page 755) command evaluates JavaScript functions on the database server and has the following form:

```
{
  eval: <function>,
  args: [ <arg1>, <arg2> ... ],
  nolock: <boolean>
}
```

The command contains the following fields:

Fields

- **function** (*JavaScript*) – A JavaScript function.

  The function may accept no arguments, as in the following example:

  ```
  function () {
    // ...
  }
  ```

  The function can also accept arguments, as in the following example:

  ```
  function (arg1, arg2) {
     // ...
  }
  ```

- **arguments** – A list of arguments to pass to the JavaScript `function` if the function accepts arguments. Omit if the `function` does not take arguments.
- **args** (*array*) – An array of corresponding arguments to the `function`. Omit `args` if the `function` does not take arguments.
- **nolock** (*boolean*) – Optional.

  By default, `eval` (page 755) takes a global write lock before evaluating the JavaScript function. As a result, `eval` (page 755) blocks all other read and write operations to the database while the `eval` (page 755) operation runs. Set `nolock` to `true` on the `eval` (page 755) command to prevent the `eval` (page 755) command from taking the global write lock before evaluating the JavaScript. `nolock` does not impact whether operations within the JavaScript code itself takes a write lock.

Consider the following example which uses `eval` (page 755) to perform an increment and calculate the average on the server:

```
db.runCommand( {
      eval: function(name, incAmount) {
                var doc = db.myCollection.findOne( { name : name } );

                doc = doc || { name : name , num : 0 , total : 0 , avg : 0 };

                doc.num++;
                doc.total += incAmount;
                doc.avg = doc.total / doc.num;

                db.myCollection.save( doc );
                return doc;
            },
      args: [ "eliot", 5 ]
   }
);
```

The db in the function refers to the current database.

The shell also provides a helper method db.eval() (page 846), so you can express the above as follows:

```
db.eval( function(name, incAmount) {
            var doc = db.myCollection.findOne( { name : name } );

            doc = doc || { name : name , num : 0 , total : 0 , avg : 0 };

            doc.num++;
            doc.total += incAmount;
            doc.avg = doc.total / doc.num;

            db.myCollection.save( doc );
            return doc;
         },
         "eliot", 5 );
```

The db.eval() (page 846) method does not support the nolock option.

If you want to use the server's interpreter, you must run eval (page 755). Otherwise, the mongo (page 908) shell's JavaScript interpreter evaluates functions entered directly into the shell.

If an error occurs, eval (page 755) throws an exception. Consider the following invalid function that uses the variable x without declaring it as an argument:

```
db.runCommand(
                {
                  eval: function() { return x + x; },
                  args: [3]
                }
              )
```

The statement will result in the following exception:

```
{
   "errno" : -3,
   "errmsg" : "invoke failed: JS Error: ReferenceError: x is not defined nofile_b:1",
   "ok" : 0
}
```

Warning:

- By default, eval (page 755) takes a global write lock before evaluating the JavaScript function. As a result, eval (page 755) blocks all other read and write operations to the database while the eval (page 755) operation runs. Set nolock to true on the eval (page 755) command to prevent the eval (page 755) command from taking the global write lock before evaluating the JavaScript. nolock does not impact whether operations within the JavaScript code itself takes a write lock.
- eval (page 755) also takes a JavaScript lock.
- Do not use eval (page 755) for long running operations as eval (page 755) blocks all other operations. Consider using *other server side code execution options* (page 438).
- You can not use eval (page 755) with *sharded* data. In general, you should avoid using eval (page 755) in *sharded cluster*; nevertheless, it is possible to use eval (page 755) with non-sharded collections and databases stored in a *sharded cluster*.
- With authentication (page 947) enabled, eval (page 755) will fail during the operation if you do not have the permission to perform a specified task.

See Also:

Server-side JavaScript (page 438)

features (internal)

features

features (page 758) is an internal command that returns the build-level feature settings.

filemd5

filemd5

The filemd5 (page 758) command returns the *md5* hashes for a single files stored using the *GridFS* specification. Client libraries use this command to verify that files are correctly written to MongoDB. The command takes the files_id of the file in question and the name of the GridFS root collection as arguments. For example:

```
{ filemd5: ObjectId("4f1f10e37671b50e4ecd2776"), root: "fs" }
```

findAndModify

findAndModify

The findAndModify (page 758) command atomically modifies and returns a single document. By default, the returned document does not include the modifications made on the update. To return the document with the modifications made on the update, use the new option.

The command has the following syntax:

```
{
  findAndModify: <string>,
  query: <document>,
  sort: <document>,
  remove: <boolean>,
  update: <document>,
  new: <boolean>,
  fields: <document>,
  upsert: <boolean>
}
```

The findAndModify (page 758) command takes the following fields:

Fields

- **findAndModify** (*string*) – Required. The collection against which to run the command.
- **query** (*document*) – Optional. Specifies the selection criteria for the modification. The query field employs the same *query selectors* (page 882) as used in the db.collection.find() (page 820) method. Although the query may match multiple documents, findAndModify (page 758) will only select one document to modify.
- **sort** (*document*) – Optional. Determines which document the operation will modify if the query selects multiple documents. findAndModify (page 758) will modify the first document in the sort order specified by this argument.
- **remove** (*boolean*) – Optional if update field exists. When true, removes the selected document. The default is false.
- **update** (*document*) – Optional if remove field exists. Performs an update of the selected document. The update field employs the same *update operators* (page 884) or field: value specifications to modify the selected document.

- **new** (*boolean*) – Optional. When `true`, returns the modified document rather than the original. The `findAndModify` (page 758) method ignores the `new` option for `remove` operations. The default is `false`.
- **fields** (*document*) – Optional. A subset of fields to return. The `fields` document specifies an inclusion of a field with `1`, as in the following:

  ```
  fields: { <field1>: 1, <field2>: 1, ... }
  ```

  See *projection* (page 115).
- **upsert** (*boolean*) – Optional. Used in conjunction with the `update` field. When `true`, the `findAndModify` (page 758) command creates a new document if the `query` returns no documents. The default is `false`.

The `findAndModify` (page 758) command returns a document, similar to the following:

```
{
   lastErrorObject: {
                        updatedExisting: <boolean>,
                        upserted: <boolean>,
                        n: <num>,
                        connectionId: <num>,
                        err: <string>,
                        ok: <num>
   }
   value: <document>,
   ok: <num>
}
```

The return document contains the following fields:

- The `lastErrorObject` field that returns the details of the command:
  - The `updatedExisting` field **only** appears if the command is either an `update` or an `upsert`.
  - The `upserted` field **only** appears if the command is an `upsert`.
- The `value` field that returns either:
  - the original (i.e. pre-modification) document if `new` is false, or
  - the modified or inserted document if `new: true`.
- The `ok` field that returns the status of the command.

Note: If the `findAndModify` (page 758) finds no matching document, then:

- for `update` or `remove` operations, `lastErrorObject` does not appear in the return document and the `value` field holds a `null`.

  ```
  { "value" : null, "ok" : 1 }
  ```

- for an `upsert` operation that performs an insert, when `new` is `false`, **and** includes a `sort` option, the return document has `lastErrorObject`, `value`, and `ok` fields, but the `value` field holds an empty document `{}`.
- for an `upsert` that performs an insert, when `new` is `false` **without** a specified `sort` the return document has `lastErrorObject`, `value`, and `ok` fields, but the `value` field holds a `null`. Changed in version 2.2: Previously, the command returned an empty document (e.g. `{}`) in the `value` field. See *the 2.2 release notes* (page 1040) for more information.

Consider the following examples:

- The following command updates an existing document in the `people` collection where the document matches the `query` criteria:

```
db.runCommand(
                {
                  findAndModify: "people",
                  query: { name: "Tom", state: "active", rating: { $gt: 10 } },
                  sort: { rating: 1 },
                  update: { $inc: { score: 1 } }
                }
              )
```

This command performs the following actions:

1. The `query` finds a document in the `people` collection where the `name` field has the value `Tom`, the `state` field has the value `active` and the `rating` field has a value `greater than` (page 697) 10.
2. The `sort` orders the results of the query in ascending order. If multiple documents meet the `query` condition, the command will select for modification the first document as ordered by this `sort`.
3. The `update` `increments` (page 699) the value of the `score` field by 1.
4. The command returns a document with the following fields:
   - The `lastErrorObject` field that contains the details of the command, including the field `updatedExisting` which is `true`, and
   - The `value` field that contains the original (i.e. pre-modification) document selected for this update:

```
{
  "lastErrorObject" : {
     "updatedExisting" : true,
     "n" : 1,
     "connectionId" : 1,
     "err" : null,
     "ok" : 1
  },
  "value" : {
     "_id" : ObjectId("50f1d54e9beb36a0f45c6452"),
     "name" : "Tom",
     "state" : "active",
     "rating" : 100,
     "score" : 5
  },
  "ok" : 1
}
```

To return the modified document in the `value` field, add the `new:true` option to the command.

If no document match the `query` condition, the command returns a document that contains `null` in the `value` field:

```
{ "value" : null, "ok" : 1 }
```

The mongo (page 908) shell and many *drivers* provide a findAndModify() (page 822) helper method. Using the shell helper, this previous operation can take the following form:

```
db.people.findAndModify( {
   query: { name: "Tom", state: "active", rating: { $gt: 10 } },
   sort: { rating: 1 },
   update: { $inc: { score: 1 } }
} );
```

However, the findAndModify() (page 822) shell helper method returns just the unmodified document, or the modified document when new is true.

```
{
   "_id" : ObjectId("50f1d54e9beb36a0f45c6452"),
   "name" : "Tom",
   "state" : "active",
   "rating" : 100,
   "score" : 5
}
```

- The following findAndModify (page 758) command includes the upsert: true option to insert a new document if no document matches the query condition:

```
db.runCommand(
               {
                 findAndModify: "people",
                 query: { name: "Gus", state: "active", rating: 100 },
                 sort: { rating: 1 },
                 update: { $inc: { score: 1 } },
                 upsert: true
               }
             )
```

If the command does **not** find a matching document, the command performs an upsert and returns a document with the following fields:

  - The lastErrorObject field that contains the details of the command, including the field upserted that contains the ObjectId of the newly inserted document, and
  - The value field that contains an empty document {} as the original document because the command included the sort option:

```
{
  "lastErrorObject" : {
     "updatedExisting" : false,
     "upserted" : ObjectId("50f2329d0092b46dae1dc98e"),
     "n" : 1,
     "connectionId" : 1,
     "err" : null,
     "ok" : 1
  },
  "value" : {

  },
  "ok" : 1
}
```

If the command did **not** include the sort option, the value field would contain null:

```
{
  "value" : null,
  "lastErrorObject" : {
     "updatedExisting" : false,
     "n" : 1,
     "upserted" : ObjectId("5102f7540cb5c8be998c2e99")
  },
  "ok" : 1
}
```

- The following `findAndModify` (page 758) command includes both `upsert: true` option and the `new:true` option to return the newly inserted document in the `value` field if a document matching the `query` is not found:

```
db.runCommand(
               {
                 findAndModify: "people",
                 query: { name: "Pascal", state: "active", rating: 25 },
                 sort: { rating: 1 },
                 update: { $inc: { score: 1 } },
                 upsert: true,
                 new: true
               }
             )
```

The command returns the newly inserted document in the `value` field:

```
{
  "lastErrorObject" : {
     "updatedExisting" : false,
     "upserted" : ObjectId("50f47909444c11ac2448a5ce"),
     "n" : 1,
     "connectionId" : 1,
     "err" : null,
     "ok" : 1
  },
  "value" : {
     "_id" : ObjectId("50f47909444c11ac2448a5ce"),
     "name" : "Pascal",
     "rating" : 25,
     "score" : 1,
     "state" : "active"
  },
  "ok" : 1
}
```

When the `findAndModify` (page 758) command includes the `upsert: true` option **and** the query field(s) is not uniquely indexed, the method could insert a document multiple times in certain circumstances. For instance, if multiple clients issue the `findAndModify` (page 758) command and these commands complete the `find` phase before any one starts the `modify` phase, these commands could insert the same document.

Consider an example where no document with the name `Andy` exists and multiple clients issue the following command:

```
db.runCommand(
               {
                 findAndModify: "people",
                 query: { name: "Andy" },
                 sort: { rating: 1 },
```

```
    update: { $inc: { score: 1 } },
    upsert: true
  }
)
```

If all the commands finish the `query` phase before any command starts the `modify` phase, **and** there is no unique index on the `name` field, the commands may all perform an upsert. To prevent this condition, create a *unique index* (page 246) on the `name` field. With the unique index in place, then the multiple `findAndModify` (page 758) commands would observe one of the following behaviors:

- Exactly one `findAndModify` (page 758) would successfully insert a new document.
- Zero or more `findAndModify` (page 758) commands would update the newly inserted document.
- Zero or more `findAndModify` (page 758) commands would fail when they attempted to insert a duplicate. If the command fails due to a unique index constraint violation, you can retry the command. Absent a delete of the document, the retry should not fail.

Warning: When using `findAndModify` (page 758) in a *sharded* environment, the `query` must contain the *shard key* for all operations against the shard cluster. `findAndModify` (page 758) operations issued against `mongos` (page 905) instances for non-sharded collections function normally.

Note: This command obtains a write lock on the affected database and will block other operations until it has completed; however, typically the write lock is short lived and equivalent to other similar `update()` (page 842) operations.

---

flushRouterConfig

`flushRouterConfig`

`flushRouterConfig` (page 763) clears the current cluster information cached by a `mongos` (page 905) instance and reloads all *sharded cluster* metadata from the *config database*.

This forces an update when the configuration database holds data that is newer that the data cached in the `mongos` (page 905) process.

Warning: Do not modify the config data, except as explicitly documented. A config database cannot typically tolerate manual manipulation.

`flushRouterConfig` (page 763) is an administrative command that is only available for `mongos` (page 905) instances. New in version 1.8.2.

forceerror (internal)

`forceerror`

The `forceerror` (page 763) command is for testing purposes only. Use `forceerror` (page 763) to force a user assertion exception. This command always returns an `ok` value of 0.

fsync

`fsync`

The `fsync` (page 763) command forces the `mongod` (page 897) process to flush all pending writes to the storage layer. `mongod` (page 897) is always writing data to the storage layer as applications write more data to

the database. MongoDB guarantees that it will write all data to disk within the syncdelay (page 951) interval, which is 60 seconds by default.

```
{ fsync: 1 }
```

The fsync (page 763) operation is synchronous by default, to run fsync (page 763) asynchronously, use the following form:

```
{ fsync: 1, async: true }
```

The connection will return immediately. You can check the output of db.currentOp() (page 846) for the status of the fsync (page 763) operation.

The primary use of fsync (page 763) is to lock the database during backup operations. This will flush all data to the data storage layer and block all write operations until you unlock the database. Consider the following command form:

```
{ fsync: 1, lock: true }
```

Note: You may continue to perform read operations on a database that has a fsync (page 763) lock. However, following the first write operation all subsequent read operations wait until you unlock the database.

To check on the current state of the fsync lock, use db.currentOp() (page 846). Use the following JavaScript function in the shell to test if the database is currently locked:

```
serverIsLocked = function () {
                     var co = db.currentOp();
                     if (co && co.fsyncLock) {
                         return true;
                     }
                     return false;
                 }
```

After loading this function into your mongo (page 908) shell session you can call it as follows:

```
serverIsLocked()
```

This function will return true if the database is currently locked and false if the database is not locked. To unlock the database, make a request for an unlock using the following command:

```
db.getSiblingDB("admin").$cmd.sys.unlock.findOne();
```

New in version 1.9.0: The db.fsyncLock() (page 848) and db.fsyncUnlock() (page 848) helpers in the shell. In the mongo (page 908) shell, you may use the db.fsyncLock() (page 848) and db.fsyncUnlock() (page 848) wrappers for the fsync (page 763) lock and unlock process:

```
db.fsyncLock();
db.fsyncUnlock();
```

Note: fsync (page 763) lock is only possible on individual shards of a sharded cluster, not on the entire sharded cluster. To backup an entire sharded cluster, please read *Sharded Cluster Backup Considerations* (page 68).

If your mongod (page 897) has *journaling* enabled, consider using *another method* (page 613) to back up your database.

Note: The database cannot be locked with `db.fsyncLock()` (page 848) while profiling is enabled. You must disable profiling before locking the database with `db.fsyncLock()` (page 848). Disable profiling using `db.setProfilingLevel()` (page 854) as follows in the `mongo` (page 908) shell:

```
db.setProfilingLevel(0)
```

geoNear

geoNear

The `geoNear` (page 765) command provides an alternative to the `$near` (page 704) operator. In addition to the functionality of `$near` (page 704), `geoNear` (page 765) returns the distance of each item from the specified point along with additional diagnostic information. For example:

```
{ geoNear : "places" , near : [50,50], num : 10 }
```

Here, `geoNear` (page 765) returns the 10 items nearest to the coordinates `[50,50]` in the collection named `places`. *geoNear* provides the following options (specify all distances in the same units as the document coordinate system:)

Fields

- **near** – Takes the coordinates (e.g. `[ x, y ]`) to use as the center of a geospatial query.
- **num** – Optional. Specifies the maximum number of documents to return. The default value is 100.
- **maxDistance** – Optional. Limits the results to those falling within a given distance of the center coordinate.
- **query** – Optional. Further narrows the results using any standard MongoDB query operator or selection. See `db.collection.find()` (page 820) and "*Query, Update, and Projection Operators Quick Reference* (page 882)" for more information.
- **spherical** – Optional. Default: `false`. When `true` MongoDB will return the query as if the coordinate system references points on a spherical plane rather than a plane.
- **distanceMultiplier** – Optional. Specifies a factor to multiply all distances returned by `geoNear` (page 765). For example, use `distanceMultiplier` to convert from spherical queries returned in radians to linear units (i.e. miles or kilometers) by multiplying by the radius of the Earth.
- **includeLocs** – Optional. Default: `false`. When specified `true`, the query will return the location of the matching documents in the result.
- **uniqueDocs** – Optional. Default `true`. The default settings will only return a matching document once, even if more than one of its location fields match the query. When `false` the query will return documents with multiple matching location fields more than once. See `$uniqueDocs` (page 719) for more information on this option

geoSearch

geoSearch

The `geoSearch` (page 765) command provides an interface to MongoDB's *haystack index* functionality. These indexes are useful for returning results based on location coordinates *after* collecting results based on some other query (i.e. a "haystack.") Consider the following example:

```
{ geoSearch : "places", near : [33, 33], maxDistance : 6, search : { type : "restaurant" }, limi
```

The above command returns all documents with a `type` of `restaurant` having a maximum distance of 6 units from the coordinates `[30,33]` in the collection `places` up to a maximum of 30 results.

Unless specified otherwise, the `geoSearch` (page 765) command limits results to 50 documents.

geoWalk

geoWalk

`geoWalk` (page 766) is an internal command.

getCmdLineOpts

getCmdLineOpts

The `getCmdLineOpts` (page 766) command returns a document containing command line options used to start the given `mongod` (page 897):

```
{ getCmdLineOpts: 1 }
```

This command returns a document with two fields, `argv` and `parsed`. The `argv` field contains an array with each item from the command string used to invoke `mongod` (page 897). The document in the `parsed` field includes all runtime options, including those parsed from the command line and those specified in the configuration file, if specified.

Consider the following example output of `getCmdLineOpts` (page 766):

```
{
        "argv" : [
                "/usr/bin/mongod",
                "--config",
                "/etc/mongodb.conf",
                "--fork"
        ],
        "parsed" : {
                "bind_ip" : "127.0.0.1",
                "config" : "/etc/mongodb/mongodb.conf",
                "dbpath" : "/srv/mongodb",
                "fork" : true,
                "logappend" : "true",
                "logpath" : "/var/log/mongodb/mongod.log",
                "quiet" : "true"
        },
        "ok" : 1
}
```

http://docs.mongodb.org/manual/administration/import-export/

getLastError

getLastError

The `getLastError` (page 766) command returns the error status of the last operation on the *current connection*. By default MongoDB does not provide a response to confirm the success or failure of a write operation, clients typically use `getLastError` (page 766) in combination with write operations to ensure that the write succeeds.

Consider the following prototype form.

```
{ getLastError: 1 }
```

The following options are available:

Parameters

- **j** (*boolean*) – If `true`, wait for the next journal commit before returning, rather than a full disk flush. If `mongod` (page 897) does not have journaling enabled, this option has no effect.
- **w** – When running with replication, this is the number of servers to replicate to before returning. A `w` value of 1 indicates the primary only. A `w` value of 2 includes the primary and at least one secondary, etc. In place of a number, you may also set `w` to `majority` to indicate that the command should wait until the latest write propagates to a majority of replica set members. If using `w`, you should also use `wtimeout`. Specifying a value for `w` without also providing a `wtimeout` may cause `getLastError` (page 766) to block indefinitely.
- **fsync** (*boolean*) – If `true`, wait for `mongod` (page 897) to write this data to disk before returning. Defaults to false. In most cases, use the `j` option to ensure durability and consistency of the data set.
- **wtimeout** (*integer*) – Optional. Milliseconds. Specify a value in milliseconds to control how long to wait for write propagation to complete. If replication does not complete in the given timeframe, the `getLastError` (page 766) command will return with an error status.

See Also:

Write Concern (page 124), *Replica Set Write Concern* (page 303), and `db.getLastError()` (page 849).

getLog

getLog

The `getLog` (page 767) command returns a document with a `log` array that contains recent messages from the `mongod` (page 897) process log. The `getLog` (page 767) command has the following syntax:

```
{ getLog: <log> }
```

Replace `<log>` with one of the following values:

- `global` - returns the combined output of all recent log entries.
- `rs` - if the `mongod` (page 897) is part of a *replica set*, `getLog` (page 767) will return recent notices related to replica set activity.
- `startupWarnings` - will return logs that *may* contain errors or warnings from MongoDB's log from when the current process started. If `mongod` (page 897) started without warnings, this filter may return an empty array.

You may also specify an asterisk (e.g. `*`) as the `<log>` value to return a list of available log filters. The following interaction from the `mongo` (page 908) shell connected to a replica set:

```
db.adminCommand({getLog: "*" })
{ "names" : [ "global", "rs", "startupWarnings" ], "ok" : 1 }
```

`getLog` (page 767) returns events from a RAM cache of the `mongod` (page 897) events and *does not* read log data from the log file.

getParameter

getParameter

getParameter (page 768) is an administrative command for retrieving the value of options normally set on the command line. Issue commands against the *admin database* as follows:

```
{ getParameter: 1, <option>: 1 }
```

The values specified for getParameter and <option> do not affect the output. The command works with the following options:

- **quiet**
- **notablescan**
- **logLevel**
- **syncdelay**

See Also:

setParameter (page 793) for more about these parameters.

getPrevError

getPrevError

The getPrevError (page 768) command returns the errors since the last resetError (page 792) command.

See Also:

db.getPrevError() (page 850)

getShardMap (internal)

getShardMap

getShardMap (page 768) is an internal command that supports the sharding functionality.

getShardVersion (internal)

getShardVersion

getShardVersion (page 768) is an internal command that supports sharding functionality.

getnonce (internal)

getnonce

Client libraries use getnonce (page 768) to generate a one-time password for authentication.

getoptime (internal)

getoptime

getoptime (page 768) is an internal command.

godinsert (internal)

godinsert

godinsert (page 769) is an internal command for testing purposes only.

Note: This command obtains a write lock on the affected database and will block other operations until it has completed.

---

group

group

The group (page 769) command groups documents in a collection by the specified key and performs simple aggregation functions such as computing counts and sums. The command is analogous to a SELECT ... GROUP BY statement in SQL. The command returns a document with the grouped records as well as the command meta-data.

The group (page 769) command takes the following prototype form:

```
{ group: { ns: <namespace>,
           key: <key>,
           $reduce: <reduce function>,
           $keyf: <key function>,
           cond: <query>,
           finalize: <finalize function> } }
```

The command fields are as follows:

Fields

- **ns** – Specifies the collection from which to perform the group by operation.
- **key** – Specifies one or more document fields to group. Returns a "key object" for use as the grouping key.
- **$reduce** – Specifies an aggregation function that operates on the documents during the grouping operation, such as compute a sum or a count. The aggregation function takes two arguments: the current document and an aggregation result document for that group.
- **initial** – Initializes the aggregation result document.
- **$keyf** – Optional. Alternative to the key field. Specifies a function that creates a "key object" for use as the grouping key. Use the keyf instead of key to group by calculated fields rather than existing document fields.
- **cond** – Optional. Specifies the selection criteria to determine which documents in the collection to process. If the cond field is omitted, the db.collection.group() (page 828) processes all the documents in the collection for the group operation.
- **finalize** – Optional. Specifies a function that runs each item in the result set before db.collection.group() (page 828) returns the final value. This function can either modify the result document or replace the result document as a whole.

Note: Unlike the $keyf and the $reduce fields that specify a function, the field name is finalize and not $finalize.

Warning:

- The `group` (page 769) command does not work with *sharded clusters*. Use the *aggregation framework* or *map-reduce* in *sharded environments*.
- The `group` (page 769) command takes a read lock and does not allow any other threads to execute JavaScript while it is running.

Note: The result set must fit within the *maximum BSON document size* (page 1021).

Additionally, in version 2.2, the returned array can contain at most 20,000 elements; i.e. at most 20,000 unique groupings. For group by operations that results in more than 20,000 unique groupings, use `mapReduce` (page 775). Previous versions had a limit of 10,000 elements.

For the shell, MongoDB provides a wrapper method `db.collection.group()` (page 828); however, the `db.collection.group()` (page 828) method takes the `keyf` field and the `reduce` field whereas the `group` (page 769) command takes the `$keyf` field and the `$reduce` field.

Consider the following examples of the `db.collection.group()` (page 828) method:

The examples assume an `orders` collection with documents of the following prototype:

```
{
  _id: ObjectId("5085a95c8fada716c89d0021"),
  ord_dt: ISODate("2012-07-01T04:00:00Z"),
  ship_dt: ISODate("2012-07-02T04:00:00Z"),
  item: { sku: "abc123",
          price: 1.99,
          uom: "pcs",
          qty: 25 }
}
```

- The following example groups by the `ord_dt` and `item.sku` fields those documents that have `ord_dt` greater than `01/01/2012`:

```
db.runCommand( { group:
                   {
                     ns: 'orders',
                     key: { ord_dt: 1, 'item.sku': 1 },
                     cond: { ord_dt: { $gt: new Date( '01/01/2012' ) } },
                     $reduce: function ( curr, result ) { },
                     initial: { }
                   }
                 } )
```

The result is a documents that contain the `retval` field which contains the group by records, the `count` field which contains the total number of documents grouped, the `keys` field which contains the number of unique groupings (i.e. number of elements in the `retval`), and the `ok` field which contains the command status:

```
{ "retval" :
      [ { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc123"},
        { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc456"},
        { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "bcd123"},
        { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "efg456"},
        { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "abc123"},
        { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "efg456"},
        { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "ijk123"},
        { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc123"},
```

```
        { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc456"},
        { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc123"},
        { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc456"}
      ],
  "count" : 13,
  "keys" : 11,
  "ok" : 1 }
```

The method call is analogous to the SQL statement:

```
SELECT ord_dt, item_sku
FROM orders
WHERE ord_dt > '01/01/2012'
GROUP BY ord_dt, item_sku
```

- The following example groups by the `ord_dt` and `item.sku` fields, those documents that have `ord_dt` greater than `01/01/2012` and calculates the sum of the `qty` field for each grouping:

```
db.runCommand( { group:
                  {
                    ns: 'orders',
                    key: { ord_dt: 1, 'item.sku': 1 },
                    cond: { ord_dt: { $gt: new Date( '01/01/2012' ) } },
                    $reduce: function ( curr, result ) {
                                result.total += curr.item.qty;
                             },
                    initial: { total : 0 }
                  }
                } )
```

The `retval` field of the returned document is an array of documents that contain the group by fields and the calculated aggregation field:

```
{ "retval" :
      [ { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc123", "total" : 25 },
        { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc456", "total" : 25 },
        { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "bcd123", "total" : 10 },
        { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "efg456", "total" : 10 },
        { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "abc123", "total" : 25 },
        { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "efg456", "total" : 15 },
        { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "ijk123", "total" : 20 },
        { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc123", "total" : 45 },
        { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc456", "total" : 25 },
        { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc123", "total" : 25 },
        { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc456", "total" : 25 }
      ],
  "count" : 13,
  "keys" : 11,
  "ok" : 1 }
```

The method call is analogous to the SQL statement:

```
SELECT ord_dt, item_sku, SUM(item_qty) as total
FROM orders
WHERE ord_dt > '01/01/2012'
GROUP BY ord_dt, item_sku
```

- The following example groups by the calculated `day_of_week` field, those documents that have `ord_dt` greater than `01/01/2012` and calculates the sum, count, and average of the `qty` field for each grouping:

```
db.runCommand( { group:
                    {
                      ns: 'orders',
                      $keyf: function(doc) {
                                return { day_of_week: doc.ord_dt.getDay() } ; },
                      cond: { ord_dt: { $gt: new Date( '01/01/2012' ) } },
                      $reduce: function ( curr, result ) {
                                  result.total += curr.item.qty;
                                  result.count++;
                                },
                      initial: { total : 0, count: 0 },
                      finalize: function(result) {
                                  var weekdays = [ "Sunday", "Monday", "Tuesday",
                                                   "Wednesday", "Thursday",
                                                   "Friday", "Saturday" ];

                                  result.day_of_week = weekdays[result.day_of_week];
                                  result.avg = Math.round(result.total / result.count);
                      }

                    }
                } )
```

The `retval` field of the returned document is an array of documents that contain the group by fields and the calculated aggregation field:

```
{ "retval" :
      [ { "day_of_week" : "Sunday", "total" : 70, "count" : 4, "avg" : 18 },
        { "day_of_week" : "Friday", "total" : 110, "count" : 6, "avg" : 18 },
        { "day_of_week" : "Tuesday", "total" : 70, "count" : 3, "avg" : 23 }

      ],
  "count" : 13,
  "keys" : 3,
  "ok" : 1 }
```

See Also:

Aggregation Framework (page 195)

handshake (internal)

handshake

`handshake` (page 772) is an internal command.

isMaster

isMaster

The `isMaster` (page 772) command provides a basic overview of the current replication configuration. MongoDB *drivers* and *clients* use this command to determine what kind of member they're connected to and to discover additional members of a *replica set*. The `db.isMaster()` (page 850) method provides a wrapper around this database command.

The command takes the following form:

```
{ isMaster: 1 }
```

This command returns a *document* containing the following fields:

isMaster.**setname**
The name of the current replica set, if applicable.

isMaster.**ismaster**
A boolean value that reports when this node is writable. If `true`, then the current node is either a *primary* in a *replica set*, a *master* in a master-slave configuration, or a standalone `mongod` (page 897).

isMaster.**secondary**
A boolean value that, when `true`, indicates that the current member is a *secondary* member of a *replica set*.

isMaster.**hosts**
An array of strings in the format of "`[hostname]:[port]`" listing all members of the *replica set* that are not "*hidden*".

isMaster.**arbiter**
An array of strings in the format of "`[hostname]:[port]`" listing all members of the *replica set* that are *arbiters*

Only appears in the `isMaster` (page 772) response for replica sets that have arbiter members.

isMaster.**arbiterOnly**
A boolean value that, when `true` indicates that the current instance is an *arbiter*.

`arbiterOnly` (page 773) only appears in the `isMaster` (page 772) response from arbiters.

isMaster.**primary**
The `[hostname]:[port]` for the current *replica set primary*, if applicable.

isMaster.**me**
The `[hostname]:[port]` of the node responding to this command.

isMaster.**maxBsonObjectSize**
The maximum permitted size of a *BSON* object in bytes for this `mongod` (page 897) process. If not provided, clients should assume a max size of "`4 * 1024 * 1024`".

isMaster.**localTime**
New in version 2.1.1. Returns the local server time in UTC. This value is a *ISOdate*. You can use the `toString()` JavaScript method to convert this value to a local date string, as in the following example:

```
db.isMaster().localTime.toString();
```

isSelf (internal)

_isSelf
`_isSelf` (page 773) is an internal command.

isdbgrid

isdbgrid
This command verifies that a process is a `mongos` (page 905).

If you issue the `isdbgrid` (page 773) command when connected to a `mongos` (page 905), the response document includes the `isdbgrid` field set to `1`. The returned document is similar to the following:

```
{ "isdbgrid" : 1, "hostname" : "app.example.net", "ok" : 1 }
```

If you issue the isdbgrid (page 773) command when connected to a mongod (page 897), MongoDB returns an error document. The isdbgrid (page 773) command is not available to mongod (page 897). The error document, however, also includes a line that reads "isdbgrid" : 1, just as in the document returned for a mongos (page 905). The error document is similar to the following:

```
{
   "errmsg" : "no such cmd: isdbgrid",
   "bad cmd" : {
         "isdbgrid" : 1
   },
   "ok" : 0
}
```

You can instead use the isMaster (page 772) command to determine connection to a mongos (page 905). When connected to a mongos (page 905), the isMaster (page 772) command returns a document that contains the string isdbgrid in the msg field.

journalLatencyTest

journalLatencyTest

journalLatencyTest (page 774) is an administrative command that tests the length of time required to write and perform a file system sync (e.g. *fsync*) for a file in the journal directory. You must issue the journalLatencyTest (page 774) command against the *admin database* in the form:

```
{ journalLatencyTest: 1 }
```

The value (i.e. 1 above), does not affect the operation of the command.

listCommands

listCommands

The listCommands (page 774) command generates a list of all database commands implemented for the current mongod (page 897) instance.

listDatabases

listDatabases

The listDatabases (page 774) command provides a list of existing databases along with basic statistics about them:

```
{ listDatabases: 1 }
```

The value (e.g. 1) does not affect the output of the command. listDatabases (page 774) returns a document for each database Each document contains a name field with the database name, a sizeOnDisk field with the total size of the database file on disk in bytes, and an empty field specifying whether the database has any data.

listShards

listShards

Use the listShards (page 774) command to return a list of configured shards. The command takes the following form:

```
{ listShards: 1 }
```

logRotate

logRotate

The logRotate (page 775) command is an administrative command that allows you to rotate the MongoDB logs to prevent a single logfile from consuming too much disk space. You must issue the logRotate (page 775) command against the *admin database* in the form:

```
{ logRotate: 1 }
```

Note: Your mongod (page 897) instance needs to be running with the *--logpath [file]* (page 898) option.

You may also rotate the logs by sending a SIGUSR1 signal to the mongod (page 897) process. If your mongod (page 897) has a process ID of 2200, here's how to send the signal on Linux:

```
kill -SIGUSR1 2200
```

logRotate (page 775) renames the existing log file by appending the current timestamp to the filename. The appended timestamp has the following form:

```
<YYYY>-<mm>-<DD>T<HH>-<MM>-<SS>
```

Then logRotate (page 775) creates a new log file with the same name as originally specified by the logpath (page 946) setting to mongod (page 897) or mongos (page 905).

Note: New in version 2.0.3: The logRotate (page 775) command is available to mongod (page 897) instances running on Windows systems with MongoDB release 2.0.3 and higher.

---

logout

logout

The logout (page 775) command terminates the current authenticated session:

```
{ logout: 1 }
```

Note: If you're not logged in and using authentication, logout (page 775) has no effect.

---

mapReduce

mapReduce

The mapReduce (page 775) command allows you to run *map-reduce* aggregation operations over a collection. The mapReduce (page 775) command has the following prototype form:

```
db.runCommand(
                {
                  mapReduce: <collection>,
                  map: <function>,
                  reduce: <function>,
                  out: <output>,
                  query: <document>,
                  sort: <document>,
                  limit: <number>,
```

```
    finalize: <function>,
    scope: <document>,
    jsMode: <boolean>,
    verbose: <boolean>
  }
)
```

Pass the name of the collection to the `mapReduce` command (i.e. `<collection>`) to use as the source documents to perform the map reduce operation. The command also accepts the following parameters:

Parameters

- **map** – A JavaScript function that associates or "maps" a `value` with a `key` and emits the `key` and value `pair`.

  The `map` function processes every input document for the map-reduce operation. The map-reduce operation groups the emitted `value` objects by the `key` and passes these groupings to the `reduce` function.

- **reduce** – A JavaScript function that "reduces" to a single object all the `values` associated with a particular `key`.

  The `reduce` function accepts two arguments: `key` and `values`. The `values` argument is an array whose elements are the `value` objects that are "mapped" to the `key`.

- **out** – New in version 1.8. Specifies the location of the result of the map-reduce operation. You can output to a collection, output to a collection with an action, or output inline. You may output to a collection when performing map reduce operations on the primary members of the set; on *secondary* members you may only use the `inline` output.

- **query** – Optional. Specifies the selection criteria using *query operators* (page 882) for determining the documents input to the `map` function.

- **sort** – Optional. Sorts the *input* documents. This option is useful for optimization. For example, specify the sort key to be the same as the emit key so that there are fewer reduce operations.

- **limit** – Optional. Specifies a maximum number of documents to return from the collection.

- **finalize** – Optional. A JavaScript function that follows the `reduce` method and modifies the output.

  The `finalize` function receives two arguments: `key` and `reducedValue`. The `reducedValue` is the value returned from the `reduce` function for the `key`.

- **scope** (*document*) – Optional. Specifies global variables that are accessible in the `map` , `reduce` and the `finalize` functions.

- **jsMode** (*Boolean*) – New in version 2.0. Optional. Specifies whether to convert intermediate data into BSON format between the execution of the `map` and `reduce` functions.

  If `false`:

  – Internally, MongoDB converts the JavaScript objects emitted by the `map` function to BSON objects. These BSON objects are then converted back to JavaScript objects when calling the `reduce` function.

  – The map-reduce operation places the intermediate BSON objects in temporary, on-disk storage. This allows the map-reduce operation to execute over arbitrarily large data sets.

  If `true`:

  - Internally, the JavaScript objects emitted during `map` function remain as JavaScript objects. There is no need to convert the objects for the `reduce` function, which can result in faster execution.
  - You can only use `jsMode` for result sets with fewer than 500,000 distinct `key` arguments to the mapper's `emit()` function.

  The `jsMode` defaults to false.

- **verbose** (*Boolean*) – Optional. Specifies whether to include the `timing` information in the result information. The `verbose` defaults to `true` to include the `timing` information.

The following is a prototype usage of the `mapReduce` (page 775) command:

```
var mapFunction = function() { ... };
var reduceFunction = function(key, values) { ... };

db.runCommand(
                {
                  mapReduce: 'orders',
                  map: mapFunction,
                  reduce: reduceFunction,
                  out: { merge: 'map_reduce_results', db: 'test' },
                  query: { ord_date: { $gt: new Date('01/01/2012') } }
                }
              )
```

Requirements for the `map` Function

The `map` function has the following prototype:

```
function() {
   ...
   emit(key, value);
}
```

The `map` function exhibits the following behaviors:

- In the `map` function, reference the current document as `this` within the function.
- The `map` function should *not* access the database for any reason.
- The `map` function should be pure, or have *no* impact outside of the function (i.e. side effects.)
- The `emit(key,value)` function associates the `key` with a `value`.
  - A single emit can only hold half of MongoDB's *maximum BSON document size* (page 1021).
  - There is no limit to the number of times you may call the `emit` function per document.
- The `map` function can access the variables defined in the `scope` parameter.

Requirements for the `reduce` Function

The `reduce` function has the following prototype:

```
function(key, values) {
   ...
   return result;
}
```

The reduce function exhibits the following behaviors:

- The reduce function should *not* access the database, even to perform read operations.
- The reduce function should *not* affect the outside system.
- MongoDB will **not** call the reduce function for a key that has only a single value.
- The reduce function can access the variables defined in the scope parameter.

Because it is possible to invoke the reduce function more than once for the same key, the following properties need to be true:

- the *type* of the return object must be **identical** to the type of the value emitted by the map function to ensure that the following operations is true:

  ```
  reduce(key, [ C, reduce(key, [ A, B ]) ] ) == reduce( key, [ C, A, B ] )
  ```

- the reduce function must be *idempotent*. Ensure that the following statement is true:

  ```
  reduce( key, [ reduce(key, valuesArray) ] ) == reduce( key, valuesArray )
  ```

- the order of the elements in the valuesArray should not affect the output of the reduce function, so that the following statement is true:

  ```
  reduce( key, [ A, B ] ) == reduce( key, [ B, A ] )
  ```

out Options

You can specify the following options for the out parameter:

Output to a Collection

```
out: <collectionName>
```

Output to a Collection with an Action This option is only available when passing out a collection that already exists. This option is not available on secondary members of replica sets.

```
out: { <action>: <collectionName>
          [, db: <dbName>]
          [, sharded: <boolean> ]
          [, nonAtomic: <boolean> ] }
```

When you output to a collection with an action, the out has the following parameters:

- <action>: Specify one of the following actions:
  - replace

    Replace the contents of the <collectionName> if the collection with the <collectionName> exists.

  - merge

    Merge the new result with the existing result if the output collection already exists. If an existing document has the same key as the new result, *overwrite* that existing document.

  - reduce

    Merge the new result with the existing result if the output collection already exists. If an existing document has the same key as the new result, apply the reduce function to both the new and the existing documents and overwrite the existing document with the result.

- db:

  Optional.The name of the database that you want the map-reduce operation to write its output. By default this will be the same database as the input collection.

- sharded:

  Optional. If true *and* you have enabled sharding on output database, the map-reduce operation will shard the output collection using the _id field as the shard key.

- nonAtomic: New in version 2.2. Optional. Specify output operation as non-atomic and is valid *only* for merge and reduce output modes which may take minutes to execute.

  If nonAtomic is true, the post-processing step will prevent MongoDB from locking the database; however, other clients will be able to read intermediate states of the output collection. Otherwise the map reduce operation must lock the database during post-processing.

Output Inline Perform the map-reduce operation in memory and return the result. This option is the only available option for out on secondary members of replica sets.

```
out: { inline: 1 }
```

The result must fit within the *maximum size of a BSON document* (page 1021).

Requirements for the finalize Function

The finalize function has the following prototype:

```
function(key, reducedValue) {
   ...
   return modifiedObject;
}
```

The finalize function receives as its arguments a key value and the reducedValue from the reduce function. Be aware that:

- The finalize function should *not* access the database for any reason.
- The finalize function should be pure, or have *no* impact outside of the function (i.e. side effects.)
- The finalize function can access the variables defined in the scope parameter.

Examples

In the mongo (page 908) shell, the db.collection.mapReduce() (page 832) method is a wrapper around the mapReduce (page 775) command. The following examples use the db.collection.mapReduce() (page 832) method:

Consider the following map-reduce operations on a collection orders that contains documents of the following prototype:

```
{
     _id: ObjectId("50a8240b927d5d8b5891743c"),
     cust_id: "abc123",
     ord_date: new Date("Oct 04, 2012"),
     status: 'A',
     price: 250,
     items: [ { sku: "mmm", qty: 5, price: 2.5 },
```

```
                { sku: "nnn", qty: 5, price: 2.5 } ]
}
```

Return the Total Price Per Customer Id Perform map-reduce operation on the `orders` collection to group by the `cust_id`, and for each `cust_id`, calculate the sum of the `price` for each `cust_id`:

1. Define the map function to process each input document:
   - In the function, `this` refers to the document that the map-reduce operation is processing.
   - The function maps the `price` to the `cust_id` for each document and emits the `cust_id` and `price` pair.

   ```
   var mapFunction1 = function() {
                          emit(this.cust_id, this.price);
                      };
   ```

2. Define the corresponding reduce function with two arguments `keyCustId` and `valuesPrices`:
   - The `valuesPrices` is an array whose elements are the `price` values emitted by the map function and grouped by `keyCustId`.
   - The function reduces the `valuesPrice` array to the sum of its elements.

   ```
   var reduceFunction1 = function(keyCustId, valuesPrices) {
                             return Array.sum(valuesPrices);
                         };
   ```

3. Perform the map-reduce on all documents in the `orders` collection using the `mapFunction1` map function and the `reduceFunction1` reduce function.

   ```
   db.orders.mapReduce(
                         mapFunction1,
                         reduceFunction1,
                         { out: "map_reduce_example" }
                       )
   ```

   This operation outputs the results to a collection named `map_reduce_example`. If the `map_reduce_example` collection already exists, the operation will replace the contents with the results of this map-reduce operation:

Calculate the Number of Orders, Total Quantity, and Average Quantity Per Item In this example you will perform a map-reduce operation on the `orders` collection, for all documents that have an `ord_date` value greater than `01/01/2012`. The operation groups by the `item.sku` field, and for each `sku` calculates the number of orders and the total quantity ordered. The operation concludes by calculating the average quantity per order for each `sku` value:

1. Define the map function to process each input document:
   - In the function, `this` refers to the document that the map-reduce operation is processing.
   - For each item, the function associates the `sku` with a new object `value` that contains the `count` of `1` and the item `qty` for the order and emits the `sku` and `value` pair.

   ```
   var mapFunction2 = function() {
                          for (var idx = 0; idx < this.items.length; idx++) {
                              var key = this.items[idx].sku;
                              var value = {
   ```

```
                                        count: 1,
                                        qty: this.items[idx].qty
                                      };
                            emit(key, value);
                        }
                    };
```

2. Define the corresponding reduce function with two arguments `keySKU` and `valuesCountObjects`:

   - `valuesCountObjects` is an array whose elements are the objects mapped to the grouped `keySKU` values passed by map function to the reducer function.
   - The function reduces the `valuesCountObjects` array to a single object `reducedValue` that also contains the `count` and the `qty` fields.
   - In `reducedValue`, the `count` field contains the sum of the `count` fields from the individual array elements, and the `qty` field contains the sum of the `qty` fields from the individual array elements.

   ```
   var reduceFunction2 = function(keySKU, valuesCountObjects) {
                             reducedValue = { count: 0, qty: 0 };

                             for (var idx = 0; idx < valuesCountObjects.length; idx++) {
                                 reducedValue.count += valuesCountObjects[idx].count;
                                 reducedValue.qty += valuesCountObjects[idx].qty;
                             }

                             return reducedValue;
                         };
   ```

3. Define a finalize function with two arguments `key` and `reducedValue`. The function modifies the `reducedValue` object to add a computed field named `average` and returns the modified object:

   ```
   var finalizeFunction2 = function (key, reducedValue) {

                               reducedValue.average = reducedValue.qty/reducedValue.count;

                               return reducedValue;
                           };
   ```

4. Perform the map-reduce operation on the `orders` collection using the `mapFunction2`, `reduceFunction2`, and `finalizeFunction2` functions.

   ```
   db.orders.mapReduce( mapFunction2,
                        reduceFunction2,
                        {
                          out: { merge: "map_reduce_example" },
                          query: { ord_date: { $gt: new Date('01/01/2012') } },
                          finalize: finalizeFunction2
                        }
                      )
   ```

   This operation uses the `query` field to select only those documents with `ord_date` greater than `new Date(01/01/2012)`. Then it output the results to a collection `map_reduce_example`. If the `map_reduce_example` collection already exists, the operation will merge the existing contents with the results of this map-reduce operation:

For more information and examples, see the *Map-Reduce* (page 223) page.

See Also:

- *map-reduce* and `db.collection.mapReduce()` (page 832)

- *Aggregation Framework* (page 195)

mapreduce.shardedfinish (internal)

mapreduce.**shardedfinish**
Provides internal functionality to support *map-reduce* in *sharded* environments.

See Also:

"mapReduce (page 775)"

medianKey (internal)

medianKey
medianKey (page 782) is an internal command.

migrateClone (internal)

_migrateClone
_migrateClone (page 782) is an internal command. Do not call directly.

moveChunk

moveChunk
moveChunk (page 782) is an internal administrative command that moves *chunks* between *shards*. You must issue the moveChunk (page 782) command against the *admin database* in the form:

```
db.runCommand( { moveChunk : <namespace> ,
                 find : <query> ,
                 to : <destination>,
                 <options> } )
```

Parameters

- **moveChunk** (*namespace*) – The name of the *collection* where the *chunk* exists. Specify the collection's full namespace, including the database name.
- **find** (*document*) – A document including the *shard key*.
- **to** (*host*) – The identifier of the shard, that you want to migrate the chunk to.
- **_secondaryThrottle** (*boolean*) – Optional. Set to false by default. If set to true, the balancer waits for replication to *secondaries* while copying and deleting data during migrations. For details, see *Require Replication before Chunk Migration (Secondary Throttle)* (page 398).

Use the sh.moveChunk() (page 868) helper in the mongo (page 908) shell to migrate chunks manually.

The *chunk migration* (page 380) section describes how chunks move between shards on MongoDB.

moveChunk (page 782) will return the following if another cursor is using the chunk you are moving:

```
errmsg: "The collection's metadata lock is already taken."
```

These errors usually occur when there are too many open *cursors* accessing the chunk you are migrating. You can either wait until the cursors complete their operation or close the cursors manually.

Note: Only use the `moveChunk` (page 782) in special circumstances such as preparing your *sharded cluster* for an initial ingestion of data, or a large bulk import operation. See *Create Chunks (Pre-Splitting)* (page 393) for more information.

---

movePrimary

movePrimary

In a *sharded cluster*, this command reassigns the database's *primary shard*, which holds all un-sharded collections in the database. `movePrimary` (page 783) is an administrative command that is only available for `mongos` (page 905) instances. Only use `movePrimary` (page 783) when removing a shard from a sharded cluster.

Important: Only use `movePrimary` (page 783) when:

- the database does not contain any collections with data, *or*
- you have drained all sharded collections using the `removeShard` (page 785) command.

See *Remove Shards from an Existing Sharded Cluster* (page 400) for a complete procedure.

`movePrimary` (page 783) changes the primary shard for this database in the cluster metadata, and migrates all un-sharded collections to the specified shard. Use the command with the following form:

```
{ movePrimary : "test", to : "shard0001" }
```

When the command returns, the database's primary location will shift to the designated *shard*. To fully decommission a shard, use the `removeShard` (page 785) command.

netstat (internal)

netstat

`netstat` (page 783) is an internal command that is only available on `mongos` (page 905) instances.

ping

ping

The `ping` (page 783) command is a no-op used to test whether a server is responding to commands. This command will return immediately even if the server is write-locked:

```
{ ping: 1 }
```

The value (e.g. `1` above,) does not impact the behavior of the command.

profile

profile

Use the `profile` (page 783) command to enable, disable, or change the query profiling level. This allows administrators to capture data regarding performance. The database profiling system can impact performance

and can allow the server to write the contents of queries to the log. Your deployment should carefully consider the security implications of this. Consider the following prototype syntax:

```
{ profile: <level> }
```

The following profiling levels are available:

Level	Setting
0	Off. No profiling.
1	On. Only includes slow operations.
2	On. Includes all operations.

You may optionally set a threshold in milliseconds for profiling using the `slowms` option, as follows:

```
{ profile: 1, slowms: 200 }
```

`mongod` (page 897) writes the output of the database profiler to the `system.profile` collection.

`mongod` (page 897) records queries that take longer than the `slowms` (page 950) to the server log even when the database profiler is not active.

See Also:

Additional documentation regarding database profiling *Database Profiling* (page 60).

See Also:

"`db.getProfilingStatus()` (page 850)" and "`db.setProfilingLevel()` (page 854)" provide wrappers around this functionality in the `mongo` (page 908) shell.

Note: The database cannot be locked with `db.fsyncLock()` (page 848) while profiling is enabled. You must disable profiling before locking the database with `db.fsyncLock()` (page 848). Disable profiling using `db.setProfilingLevel()` (page 854) as follows in the `mongo` (page 908) shell:

```
db.setProfilingLevel(0)
```

Note: This command obtains a write lock on the affected database and will block other operations until it has completed. However, the write lock is only held while enabling or disabling the profiler. This is typically a short operation.

---

reIndex

`reIndex`

The `reIndex` (page 784) command rebuilds all indexes for a specified collection. Use the following syntax:

```
{ reIndex: "collection" }
```

Normally, MongoDB compacts indexes during routine updates. For most users, the `reIndex` (page 784) command is unnecessary. However, it may be worth running if the collection size has changed significantly or if the indexes are consuming a disproportionate amount of disk space.

Call `reIndex` (page 784) using the following form:

```
db.collection.reIndex();
```

> **Warning:** This command obtains a write lock on the affected database and will block other operations until it has completed.

Note: For replica sets, `reIndex` (page 784) will not propagate from the *primary* to *secondaries*. `reIndex` (page 784) will only affect a single `mongod` (page 897) instance.

recvChunkAbort (internal)

_recvChunkAbort

`_recvChunkAbort` (page 785) is an internal command. Do not call directly.

recvChunkCommit (internal)

_recvChunkCommit

`_recvChunkCommit` (page 785) is an internal command. Do not call directly.

recvChunkStart (internal)

_recvChunkStart

`_recvChunkStart` (page 785) is an internal command. Do not call directly.

Warning: This command obtains a write lock on the affected database and will block other operations until it has completed.

recvChunkStatus (internal)

_recvChunkStatus

`_recvChunkStatus` (page 785) is an internal command. Do not call directly.

removeShard

removeShard

Starts the process of removing a shard from a *cluster*. This is a multi-stage process. Begin by issuing the following command:

```
{ removeShard : "[shardName]" }
```

The balancer will then migrate chunks from the shard specified by `[shardName]`. This process happens slowly to avoid placing undue load on the overall cluster.

The command returns immediately, with the following message:

```
{ msg : "draining started successfully" , state: "started" , shard: "shardName" , ok : 1 }
```

If you run the command again, you'll see the following progress output:

```
{ msg: "draining ongoing" , state: "ongoing" , remaining: { chunks: 23 , dbs: 1 }, ok: 1 }
```

The `remaining` *document* specifies how many chunks and databases remain on the shard. Use `db.printShardingStatus()` (page 852) to list the databases that you must move from the shard.

Each database in a sharded cluster has a primary shard. If the shard you want to remove is also the primary of one of the cluster's databases, then you must manually move the database to a new shard. This can be only after the shard is empty. See the `movePrimary` (page 783) command for details.

After removing all chunks and databases from the shard, you may issue the command again, to return:

```
{ msg: "remove shard completed successfully , stage: "completed", host: "shardName", ok : 1 }
```

renameCollection

renameCollection

The renameCollection (page 786) command is an administrative command that changes the name of an existing collection. You specify collections to renameCollection (page 786) in the form of a complete *namespace*, which includes the database name. To rename a collection, issue the renameCollection (page 786) command against the *admin database* in the form:

```
{ renameCollection: <source-namespace>, to: <target-namespace>[, dropTarget: <boolean> ] }
```

The dropTarget argument is optional.

If you specify a collection to the to argument in a different database, the renameCollection (page 786) command will copy the collection to the new database and then drop the source collection.

Parameters

- **source-namespace** – Specifies the complete namespace of the collection to rename.
- **to** (*string*) – Specifies the new namespace of the collection.
- **dropTarget** (*boolean*) – Optional. If true, mongod (page 897) will drop the target of renameCollection (page 786) prior to renaming the collection.

Exception

- **10026** – Raised if the source namespace does not exist.
- **10027** – Raised if the target namespace exists and dropTarget is either false or unspecified.
- **15967** – Raised if the target namespace is an invalid collection name.

You can use renameCollection (page 786) in production environments; however:

- renameCollection (page 786) will block all database activity for the duration of the operation.
- renameCollection (page 786) is incompatible with sharded collections.

Warning: renameCollection (page 786) will fail if *target* is the name of an existing collection and you do not specify dropTarget: true.
If the renameCollection (page 786) operation does not complete the target collection and indexes will not be usable and will require manual intervention to clean up.

The shell helper db.collection.renameCollection() (page 839) provides a simpler interface to using this command within a database. The following is equivalent to the previous example:

```
db.source-namespace.renameCollection( "target" )
```

Warning: You cannot use renameCollection (page 786) with sharded collections.

Warning: This command obtains a global write lock and will block other operations until it has completed.

repairDatabase

repairDatabase

> **Warning:** In general, if you have an intact copy of your data, such as would exist on a very recent backup or an intact member of a *replica set*, **do not** use `repairDatabase` (page 787) or related options like `db.repairDatabase()` (page 853) in the `mongo` (page 908) shell or *`mongod --repair`* (page 901). Restore from an intact copy of your data.

Note: When using *journaling*, there is almost never any need to run `repairDatabase` (page 787). In the event of an unclean shutdown, the server will be able restore the data files to a pristine state automatically.

The `repairDatabase` (page 787) command checks and repairs errors and inconsistencies with the data storage. The command is analogous to a `fsck` command for file systems.

If your `mongod` (page 897) instance is not running with journaling the system experiences an unexpected system restart or crash, and you have *no* other intact replica set members with this data, you should run the `repairDatabase` (page 787) command to ensure that there are no errors in the data storage.

As a side effect, the `repairDatabase` (page 787) command will compact the database, as the `compact` (page 746) command, and also reduces the total size of the data files on disk. The `repairDatabase` (page 787) command will also recreate all indexes in the database.

Use the following syntax:

```
{ repairDatabase: 1 }
```

Be aware that this command can take a long time to run if your database is large. In addition, it requires a quantity of free disk space equal to the size of your database. If you lack sufficient free space on the same volume, you can mount a separate volume and use that for the repair. In this case, you must run the command line and use the *`--repairpath`* (page 902) switch to specify the folder in which to store the temporary repair files.

> **Warning:** This command obtains a global write lock and will block other operations until it has completed.

This command is accessible via a number of different avenues. You may:

- Use the shell to run the above command, as above.
- Use the `db.repairDatabase()` (page 853) in the `mongo` (page 908) shell.
- Run `mongod` (page 897) directly from your system's shell. Make sure that `mongod` (page 897) isn't already running, and that you issue this command as a user that has access to MongoDB's data files. Run as:

  ```
  $ mongod --repair
  ```

  To add a repair path:

  ```
  $ mongod --repair --repairpath /opt/vol2/data
  ```

  Note: This command will fail if your database is not a master or primary. In most cases, you should recover a corrupt secondary using the data from an existing intact node. If you must repair a secondary or slave node, first restart the node as a standalone mongod by omitting the *`--replSet`* (page 903) or *`--slave`* (page 903) options, as necessary.

  ---

replSetElect (internal)

replSetElect
replSetElect (page 788) is an internal command that support replica set functionality.

replSetFreeze

replSetFreeze
The replSetFreeze (page 788) command prevents a replica set member from seeking election for the specified number of seconds. Use this command in conjunction with the replSetStepDown (page 790) command to make a different node in the replica set a primary.

The replSetFreeze (page 788) command uses the following syntax:

```
{ replSetFreeze: <seconds> }
```

If you want to unfreeze a replica set member before the specified number of seconds has elapsed, you can issue the command with a seconds value of 0:

```
{ replSetFreeze: 0 }
```

Restarting the mongod (page 897) process also unfreezes a replica set member.

replSetFreeze (page 788) is an administrative command, and you must issue the it against the *admin database*.

replSetFresh (internal)

replSetFresh
replSetFresh (page 788) is an internal command that supports replica set functionality.

replSetGetRBID (internal)

replSetGetRBID
replSetGetRBID (page 788) is an internal command that supports replica set functionality.

replSetGetStatus

replSetGetStatus
The replSetGetStatus command returns the status of the replica set from the point of view of the current server. You must run the command against the *admin database*. The command has the following prototype format:

```
{ replSetGetStatus: 1 }
```

However, you can also run this command from the shell like so:

```
rs.status()
```

See Also:

"*Replica Set Status Reference* (page 987)" and "*Replica Set Fundamental Concepts* (page 279)"

replSetHeartbeat (internal)

replSetHeartbeat

replSetHeartbeat (page 789) is an internal command that supports replica set functionality.

replSetInitiate

replSetInitiate

The replSetInitiate (page 789) command initializes a new replica set. Use the following syntax:

```
{ replSetInitiate : <config_document> }
```

The <config_document> is a *document* that specifies the replica set's configuration. For instance, here's a config document for creating a simple 3-member replica set:

```
{
    _id : <setname>,
     members : [
         {_id : 0, host : <host0>},
         {_id : 1, host : <host1>},
         {_id : 2, host : <host2>},
     ]
}
```

A typical way of running this command is to assign the config document to a variable and then to pass the document to the rs.initiate() (page 860) helper:

```
  config = {
      _id : "my_replica_set",
       members : [
           {_id : 0, host : "rs1.example.net:27017"},
           {_id : 1, host : "rs2.example.net:27017"},
           {_id : 2, host : "rs3.example.net", arbiterOnly: true},
       ]
  }

  rs.initiate(config)
```

```
Notice that omitting the port cause the host to use the default port
of 27017. Notice also that you can specify other options in the config
documents such as the ``arbiterOnly`` setting in this example.
```

See Also:

"*Replica Set Configuration* (page 989)," "*Replica Set Operation and Management* (page 285)," and "*Replica Set Reconfiguration* (page 993)."

replSetMaintenance

replSetMaintenance

The replSetMaintenance (page 789) admin command enables or disables the maintenance mode for a *secondary* member of a *replica set*.

The command has the following prototype form:

```
{ replSetMaintenance: <boolean> }
```

Consider the following behavior when running the replSetMaintenance (page 789) command:

- You cannot run the command on the Primary.
- You must run the command against the `admin` database.
- When enabled `replSetMaintenance: 1`, the member enters the `RECOVERING` state. While the secondary is `RECOVERING`:
  - The member is not accessible for read operations.
  - The member continues to sync its *oplog* from the Primary.

replSetReconfig

`replSetReconfig`

The `replSetReconfig` (page 790) command modifies the configuration of an existing replica set. You can use this command to add and remove members, and to alter the options set on existing members. Use the following syntax:

```
{ replSetReconfig: <new_config_document>, force: false }
```

You may also run the command using the shell's `rs.reconfig()` (page 860) method.

Be aware of the following `replSetReconfig` (page 790) behaviors:

- You must issue this command against the *admin database* of the current primary member of the replica set.
- You can optionally force the replica set to accept the new configuration by specifying `force: true`. Use this option if the current member is not primary or if a majority of the members of the set are not accessible.

  Warning: Forcing the `replSetReconfig` (page 790) command can lead to a *rollback* situation. Use with caution.

  Use the force option to restore a replica set to new servers with different hostnames. This works even if the set members already have a copy of the data.
- A majority of the set's members must be operational for the changes to propagate properly.
- This command can cause downtime as the set renegotiates primary-status. Typically this is 10-20 seconds, but could be as long as a minute or more. Therefore, you should attempt to reconfigure only during scheduled maintenance periods.
- In some cases, `replSetReconfig` (page 790) forces the current primary to step down, initiating an election for primary among the members of the replica set. When this happens, the set will drop all current connections.

Note: `replSetReconfig` (page 790) obtains a special mutually exclusive lock to prevent more than one `replSetReconfig` (page 790) operation from occurring at the same time.

---

replSetStepDown

`replSetStepDown`

Options

- **force** (*boolean*) – Forces the *primary* to step down even if there aren't any secondary members within 10 seconds of the primary's latest optime. This option is not available in versions of `mongod` (page 897) before 2.0.

The `replSetStepDown` (page 790) command forces the *primary* of the replica set to relinquish its status as primary. This initiates an *election for primary* (page 314). You may specify a number of seconds for the node to avoid election to primary:

```
{ replSetStepDown: <seconds> }
```

If you do not specify a value for `<seconds>`, `replSetStepDown` (page 790) will attempt to avoid reelection to primary for 60 seconds.

Warning: This will force all clients currently connected to the database to disconnect. This help to ensure that clients maintain an accurate view of the replica set.

New in version 2.0: If there is no *secondary*, within 10 seconds of the primary, `replSetStepDown` (page 790) will not succeed to prevent long running elections.

replSetSyncFrom

`replSetSyncFrom`

New in version 2.2.

Options

- **host** – Specifies the name and port number of the replica set member that this member replicates from. Use the `[hostname]:[port]` form.

`replSetSyncFrom` (page 791) allows you to explicitly configure which host the current `mongod` (page 897) will poll *oplog* entries from. This operation may be useful for testing different patterns and in situations where a set member is not replicating from the host you want. The member to replicate from must be a valid source for data in the set.

A member cannot replicate from:

- itself.
- an arbiter, because arbiters do not hold data.
- a member that does not build indexes.
- an unreachable member.
- a `mongod` (page 897) instance that is not a member of the same replica set.

If you attempt to replicate from a member that is more than 10 seconds behind the current member, `mongod` (page 897) will return and log a warning, but it still *will* replicate from the member that is behind.

If you run `rs.syncFrom()` (page 862) during initial sync, MongoDB produces no error messages, but the sync target will not change until after the initial sync operation.

The command has the following prototype form:

```
{ replSetSyncFrom: "[hostname]:[port]" }
```

To run the command in the `mongo` (page 908) shell, use the following invocation:

```
db.adminCommand( { replSetSyncFrom: "[hostname]:[port]" } )
```

You may also use the `rs.syncFrom()` (page 862) helper in the `mongo` (page 908) shell, in an operation with the following form:

```
rs.syncFrom("[hostname]:[port]")
```

Note: replSetSyncFrom (page 791) and rs.syncFrom() (page 862) provide a temporary override of default behavior. If:

- the mongod (page 897) instance restarts or
- the connection to the sync target closes;

then, the mongod (page 897) instance will revert to the default sync logic and target.

---

replSetTest (internal)

replSetTest

replSetTest (page 792) is internal diagnostic command used for regression tests that supports replica set functionality.

resetError

resetError

The resetError (page 792) command resets the last error status.

See Also:

db.resetError() (page 853)

resync

resync

The resync (page 792) command forces an out-of-date slave mongod (page 897) instance to re-synchronize itself. Note that this command is relevant to master-slave replication only. It does not apply to replica sets.

> **Warning:** This command obtains a global write lock and will block other operations until it has completed.

serverStatus

serverStatus

The serverStatus (page 792) command returns a document that provides an overview of the database process's state. Most monitoring applications run this command at a regular interval to collection statistics about the instance:

```
{ serverStatus: 1 }
```

The value (i.e. 1 above), does not affect the operation of the command.

See Also:

db.serverStatus() (page 854) and "*Server Status Reference* (page 965)"

setParameter

setParameter

setParameter (page 793) is an administrative command for modifying options normally set on the command line. You must issue the setParameter (page 793) command against the *admin database* in the form:

```
{ setParameter: 1, <option>: <value> }
```

Replace the <option> with one of the following options supported by this command:

Options

- **journalCommitInterval** (*integer*) – Specify an integer between 1 and 500 signifying the number of milliseconds (ms) between journal commits.

  Consider the following example which sets the journalCommitInterval to 200 ms:

  ```
  use admin
  db.runCommand( { setParameter: 1, journalCommitInterval: 200 } )
  ```

  See Also:

  journalCommitInterval (page 948).

- **logLevel** (*integer*) – Specify an integer between 0 and 5 signifying the verbosity of the logging, where 5 is the most verbose.

  Consider the following example which sets the logLevel to 2:

  ```
  use admin
  db.runCommand( { setParameter: 1, logLevel: 2 } )
  ```

  See Also:

  verbose (page 945).

- **notablescan** (*boolean*) – Specify whether queries must use indexes. If true, queries that perform a table scan instead of using an index will fail.

  Consider the following example which sets the notablescan to true:

  ```
  use admin
  db.runCommand( { setParameter: 1, notablescan: true } )
  ```

  See Also:

  notablescan (page 949).

- **traceExceptions** (*boolean*) – New in version 2.1. Configures mongod (page 897) log full stack traces on assertions or errors. If true, mongod (page 897) will log full stack traces on assertions or errors.

  Consider the following example which sets the traceExceptions to true:

  ```
  use admin
  db.runCommand( { setParameter: 1, traceExceptions: true } )
  ```

  See Also:

  traceExceptions (page 951).

- **quiet** (*boolean*) – Sets quiet logging mode. If `true`, `mongod` (page 897) will go into a quiet logging mode which will not log the following events/activities:
  - connection events;
  - the `drop` (page 754) command, the `dropIndexes` (page 755) command, the `diagLogging` (page 753) command, the `validate` (page 799) command, and the `clean` (page 742) command; and
  - replication synchronization activities.

  Consider the following example which sets the `quiet` to true:

  ```
  use admin
  db.runCommand( { setParameter: 1, quiet: true } )
  ```

  See Also:

  `quiet` (page 951).

- **syncdelay** (*integer*) – Specify the interval in seconds between *fsyncs* (i.e., flushes of memory to disk). By default, `mongod` (page 897) will flush memory to disk every 60 seconds. Do not change this value unless you see a background flush average greater than 60 seconds.

  Consider the following example which sets the `syncdelay` to `60` seconds:

  ```
  use admin
  db.runCommand( { setParameter: 1, syncdelay: 60 } )
  ```

  See Also:

  `syncdelay` (page 951).

setShardVersion

setShardVersion

`setShardVersion` (page 794) is an internal command that supports sharding functionality.

shardCollection

shardCollection

The `shardCollection` (page 794) command marks a collection for sharding and will allow data to begin distributing among shards. You must run `enableSharding` (page 755) on a database before running the `shardCollection` (page 794) command.

```
{ shardCollection: "<db>.<collection>", key: <shardkey> }
```

This enables sharding for the collection specified by `<collection>` in the database named `<db>`, using the key `<shardkey>` to distribute documents among the shard. `<shardkey>` is a document, and takes the same form as an *index specification document* (page 140).

Choosing the right shard key to effectively distribute load among your shards requires some planning.

See Also:

Sharding (page 363) for more information related to sharding. Also consider the section on *Shard Key Selection* (page 365) for documentation regarding shard keys.

Warning: There's no easy way to disable sharding after running `shardCollection` (page 794). In addition, you cannot change shard keys once set. If you must convert a sharded cluster to a *standalone* node or *replica set*, you must make a single backup of the entire cluster and then restore the backup to the standalone `mongod` (page 897) or the replica set..

shardingState

shardingState

`shardingState` (page 795) is an admin command that reports if `mongod` (page 897) is a member of a *sharded cluster*. `shardingState` (page 795) has the following prototype form:

```
{ shardingState: 1 }
```

For `shardingState` (page 795) to detect that a `mongod` (page 897) is a member of a sharded cluster, the `mongod` (page 897) must satisfy the following conditions:

1. the `mongod` (page 897) is a primary member of a replica set, and
2. the `mongod` (page 897) instance is a member of a sharded cluster.

If `shardingState` (page 795) detects that a `mongod` (page 897) is a member of a sharded cluster, `shardingState` (page 795) returns a document that resembles the following prototype:

```
{
  "enabled" : true,
  "configServer" : "<configdb-string>",
  "shardName" : "<string>",
  "shardHost" : "string:",
  "versions" : {
       "<database>.<collection>" : Timestamp(<...>),
       "<database>.<collection>" : Timestamp(<...>)
  },
  "ok" : 1
}
```

Otherwise, `shardingState` (page 795) will return the following document:

```
{ "note" : "from execCommand", "ok" : 0, "errmsg" : "not master" }
```

The response from `shardingState` (page 795) when used with a *config server* is:

```
{ "enabled": false, "ok": 1 }
```

Note: `mongos` (page 905) instances do not provide the `shardingState` (page 795).

Warning: This command obtains a write lock on the affected database and will block other operations until it has completed; however, the operation is typically short lived.

shutdown

shutdown

The `shutdown` (page 795) command cleans up all database resources and then terminates the process. You must issue the `shutdown` (page 795) command against the *admin database* in the form:

```
{ shutdown: 1 }
```

Note: Run the shutdown (page 795) against the *admin database*. When using shutdown (page 795), the connection must originate from localhost **or** use an authenticated connection.

If the node you're trying to shut down is a *replica set* (page 279) primary, then the command will succeed only if there exists a secondary node whose oplog data is within 10 seconds of the primary. You can override this protection using the `force` option:

```
{ shutdown: 1, force: true }
```

Alternatively, the shutdown (page 795) command also supports a `timeoutSecs` argument which allows you to specify a number of seconds to wait for other members of the replica set to catch up:

```
{ shutdown: 1, timeoutSecs: 60 }
```

The equivalent mongo (page 908) shell helper syntax looks like this:

```
db.shutdownServer({timeoutSecs: 60});
```

skewClockCommand (internal)

_skewClockCommand

_skewClockCommand (page 796) is an internal command. Do not call directly.

sleep (internal)

sleep

sleep (page 796) is an internal command for testing purposes. The sleep (page 796) command forces the database to block all operations. It takes the following options:

Parameters

- **w** (*boolean*) – If true, obtain a global write lock. Otherwise obtains a read lock.
- **secs** (*integer*) – Specifies the number of seconds to sleep.

```
{ sleep: { w: true, secs: <seconds> } }
```

The above command places the mongod (page 897) instance in a "write-lock" state for a specified (i.e. <seconds>) number of seconds. Without arguments, sleep (page 796), causes a "read lock" for 100 seconds.

Warning: sleep (page 796) claims the lock specified in the `w` argument and blocks *all* operations on the mongod (page 897) instance for the specified amount of time.

split

split

The split (page 796) command creates new *chunks* in a *sharded* environment. While splitting is typically managed automatically by the mongos (page 905) instances, this command makes it possible for administrators to manually create splits.

In most clusters, MongoDB will manage all chunk creation and distribution operations without manual intervention.

> **Warning:** Be careful when splitting data in a sharded collection to create new chunks. When you shard a collection that has existing data, MongoDB automatically creates chunks to evenly distribute the collection. To split data effectively in a sharded cluster you must consider the number of documents in a chunk and the average document size to create a uniform chunk size. When chunks have irregular sizes, shards may have an equal number of chunks but have very different data sizes. Avoid creating splits that lead to a collection with differently sized chunks.

Consider the following example:

```
db.runCommand( { split : "test.people" , find : { _id : 99 } } )
```

This command inserts a new split in the collection named `people` in the `test` database. This will split the chunk that contains the document that matches the query `{ _id : 99 }` in half. If the document specified by the query does not (yet) exist, the `split` (page 796) will divide the chunk where that document *would* exist.

The split divides the chunk in half, and does *not* split the chunk using the identified document as the middle. To define an arbitrary split point, use the following form:

```
db.runCommand( { split : "test.people" , middle : { _id : 99 } } )
```

This form is typically used when *pre-splitting* data in a collection.

`split` (page 796) is an administrative command that is only available for `mongos` (page 905) instances.

splitChunk

splitChunk

`splitChunk` (page 797) is an internal command. Use the `sh.splitFind()` (page 870) and `sh.splitAt()` (page 870) functions in the `mongo` (page 908) shell to access this functionality.

> **Warning:** Be careful when splitting data in a sharded collection to create new chunks. When you shard a collection that has existing data, MongoDB automatically creates chunks to evenly distribute the collection. To split data effectively in a sharded cluster you must consider the number of documents in a chunk and the average document size to create a uniform chunk size. When chunks have irregular sizes, shards may have an equal number of chunks but have very different data sizes. Avoid creating splits that lead to a collection with differently sized chunks.

splitVector

splitVector

Is an internal command that supports meta-data operations in sharded clusters.

testDistLockWithSkew (internal)

_testDistLockWithSkew

`_testDistLockWithSkew` (page 797) is an internal command. Do not call directly.

testDistLockWithSyncCluster (internal)

_testDistLockWithSyncCluster

_testDistLockWithSyncCluster (page 798) is an internal command. Do not call directly.

top

top

The top (page 798) command is an administrative command which returns raw usage of each database, and provides amount of time, in microseconds, used and a count of operations for the following event types:

- total
- readLock
- writeLock
- queries
- getmore
- insert
- update
- remove
- commands

You must issue the top (page 798) command against the *admin database* in the form:

```
{ top: 1 }
```

touch

touch

New in version 2.2. The touch (page 798) command loads data from the data storage layer into memory. touch (page 798) can load the data (i.e. documents,) indexes or both documents and indexes. Use this command to ensure that a collection, and/or its indexes, are in memory before another operation. By loading the collection or indexes into memory, mongod (page 897) will ideally be able to perform subsequent operations more efficiently. The touch (page 798) command has the following prototypical form:

```
{ touch: [collection], data: [boolean], index: [boolean] }
```

By default, data and index are false, and touch (page 798) will perform no operation. For example, to load both the data and the index for a collection named records, you would use the following command in the mongo (page 908) shell:

```
db.runCommand({ touch: "records", data: true, index: true })
```

touch (page 798) will not block read and write operations on a mongod (page 897), and can run on *secondary* members of replica sets.

Note: Using touch (page 798) to control or tweak what a mongod (page 897) stores in memory may displace other records data in memory and hinder performance. Use with caution in production systems.

> **Warning:** If you run `touch` (page 798) on a secondary, the secondary will enter a `RECOVERING` state to prevent clients from sending read operations during the `touch` (page 798) operation. When `touch` (page 798) finishes the secondary will automatically return to `SECONDARY` state. See `state` (page 988) for more information on replica set member states.

transferMods (internal)

_transferMods

`_transferMods` (page 799) is an internal command. Do not call directly.

unsetSharding (internal)

unsetSharding

`unsetSharding` (page 799) is an internal command that supports sharding functionality.

validate

validate

The `validate` command checks the contents of a namespace by scanning a collection's data and indexes for correctness. The command can be slow, particularly on larger data sets:

```
{ validate: "users" }
```

This command will validate the contents of the collection named `users`. You may also specify one of the following options:

- `full: true` provides a more thorough scan of the data.
- **`scandata: false` skips the scan of the base collection** without skipping the scan of the index.

The `mongo` (page 908) shell also provides a wrapper:

```
db.collection.validate();
```

Use one of the following forms to perform the full collection validation:

```
db.collection.validate(true)
db.runCommand( { validate: "collection", full: true } )
```

> **Warning:** This command is resource intensive and may have an impact on the performance of your MongoDB instance.

whatsmyuri (internal)

whatsmyuri

`whatsmyuri` (page 799) is an internal command.

writeBacksQueued (internal)

writeBacksQueued

`writeBacksQueued` (page 799) is an internal command that returns a document reporting there are operations in the write back queue for the given `mongos` (page 905) and information about the queues.

writeBacksQueued.**hasOpsQueued**
: Boolean.

  hasOpsQueued (page 799) is `true` if there are `write Back` operations queued.

writeBacksQueued.**totalOpsQueued**
: Integer.

  totalOpsQueued (page 800) reflects the number of operations queued.

writeBacksQueued.**queues**
: Document.

  queues (page 800) holds a sub-document where the fields are all write back queues. These field hold a document with two fields that reports on the state of the queue. The fields in these documents are:

  writeBacksQueued.queues.**n**
  : n (page 800) reflects the size, by number of items, in the queues.

  writeBacksQueued.queues.**minutesSinceLastCall**
  : The number of minutes since the last time the mongos (page 905) touched this queue.

The command document has the following prototype form:

```
{writeBacksQueued: 1}
```

To call writeBacksQueued (page 799) from the mongo (page 908) shell, use the following db.runCommand() (page 853) form:

```
db.runCommand({writeBacksQueued: 1})
```

Consider the following example output:

```
{
  "hasOpsQueued" : true,
  "totalOpsQueued" : 7,
  "queues" : {
          "50b4f09f6671b11ff1944089" : { "n" : 0, "minutesSinceLastCall" : 1 },
          "50b4f09fc332bf1c5aeaaf59" : { "n" : 0, "minutesSinceLastCall" : 0 },
          "50b4f09f6671b1d51df98cb6" : { "n" : 0, "minutesSinceLastCall" : 0 },
          "50b4f0c67ccf1e5c6effb72e" : { "n" : 0, "minutesSinceLastCall" : 0 },
          "50b4faf12319f193cfdec0d1" : { "n" : 0, "minutesSinceLastCall" : 4 },
          "50b4f013d2c1f8d62453017e" : { "n" : 0, "minutesSinceLastCall" : 0 },
          "50b4f0f12319f193cfdec0d1" : { "n" : 0, "minutesSinceLastCall" : 1 }
  },
  "ok" : 1
}
```

writebacklisten (internal)

writebacklisten
: writebacklisten (page 800) is an internal command.

61.1.3 JavaScript Methods

Date()

Date()

Returns Current date, as a string.

Mongo()

Mongo()

JavaScript constructor to instantiate a database connection from the mongo (page 908) shell or from a JavaScript file.

Parameters

- **host** (*string*) – Optional. Either in the form of <host> or <host><:port>.
  - Pass the <host> parameter to the constructor to instantiate a connection to the <host> and the default port.
  - Pass the <host><:port> parameter to the constructor to instantiate a connection to the <host> and the <port>.

  Use the constructor without a parameter to instantiate a connection to the localhost interface on the default port.

See Also:

Mongo.getDB() (page 801)

Mongo.getDB()

Mongo.**getDB**(<*database*>)

Mongo.getDB() (page 801) provides access to database objects from the mongo (page 908) shell or from a JavaScript file.

Parameters

- **database** (*string*) – The name of the database to access.

The following example instantiates a new connection to the MongoDB instance running on the localhost interface and returns a reference to "myDatabase":

```
db = new Mongo().getDB("myDatabase");
```

See Also:

Mongo() (page 801) and *connect()* (page 803)

ObjectId.getTimestamp()

ObjectId.**getTimestamp**()

Returns The timestamp portion of the *ObjectId()* (page 142) object as a Date.

In the following example, call the getTimestamp() (page 801) method on an ObjectId (e.g. ObjectId("507c7f79bcf86cd7994f6c0e")):

```
ObjectId("507c7f79bcf86cd7994f6c0e").getTimestamp()
```

This will return the following output:

```
ISODate("2012-10-15T21:26:17Z")
```

ObjectId.toString()

`ObjectId.toString()`

Returns The string representation of the *ObjectId()* (page 142) object. This value has the format of `ObjectId(...)`.

Changed in version 2.2: In previous versions `ObjectId.toString()` (page 802) returns the value of the ObjectId as a hexadecimal string. In the following example, call the `toString()` (page 802) method on an ObjectId (e.g. `ObjectId("507c7f79bcf86cd7994f6c0e")`):

```
ObjectId("507c7f79bcf86cd7994f6c0e").toString()
```

This will return the following string:

```
ObjectId("507c7f79bcf86cd7994f6c0e")
```

You can confirm the type of this object using the following operation:

```
typeof ObjectId("507c7f79bcf86cd7994f6c0e").toString()
```

ObjectId.valueOf()

`ObjectId.valueOf()`

Returns The value of the *ObjectId()* (page 142) object as a lowercase hexadecimal string. This value is the `str` attribute of the `ObjectId()` object.

Changed in version 2.2: In previous versions `ObjectId.valueOf()` (page 802) returns the `ObjectId()` object. In the following example, call the `valueOf()` (page 802) method on an ObjectId (e.g. `ObjectId("507c7f79bcf86cd7994f6c0e")`):

```
ObjectId("507c7f79bcf86cd7994f6c0e").valueOf()
```

This will return the following string:

```
507c7f79bcf86cd7994f6c0e
```

You can confirm the type of this object using the following operation:

```
typeof ObjectId("507c7f79bcf86cd7994f6c0e").valueOf()
```

cat()

cat(*filename*)

Parameters

- **filename** (*string*) – Specify a path and file name on the local file system.

Returns the contents of the specified file.

This function returns with output relative to the current shell session, and does not impact the server.

cd()

cd(*path*)

Parameters

- **path** (*string*) – Specify a path on the local file system.

Changes the current working directory to the specified path.

This function returns with output relative to the current shell session, and does not impact the server.

Note: This feature is not yet implemented.

---

clearRawMongoProgramOutput()

clearRawMongoProgramOutput()
For internal use.

connect()

connect(*<hostname><:port>/<database>*)
The `connect()` method creates a connection to a MongoDB instance. However, use the `Mongo()` (page 801) object and its `getDB()` (page 801) method in most cases.

`connect()` accepts a string `<hostname><:port>/<database>` parameter to connect to the MongoDB instance on the `<hostname><:port>` and return the reference to the database `<database>`.

The following example instantiates a new connection to the MongoDB instance running on the localhost interface and returns a reference to `myDatabase`:

```
db = connect("localhost:27017/myDatabase")
```

See Also:

`Mongo.getDB()` (page 801)

copyDbpath()

copyDbpath()
For internal use.

cursor.addOption()

`cursor.`**addOption**(*<flag>*)
Use the `cursor.addOption()` (page 803) method on a cursor to add `OP_QUERY` wire protocol flags, such as the `tailable` flag, to change the behavior of queries.

Parameters

- **flag** – `OP_QUERY` wire protocol flag. See MongoDB wire protocol for more information on MongoDB Wire Protocols and the OP_QUERY flags.

  For the `mongo` (page 908) shell, you can use the cursor flags listed in the *Cursor Flags* (page 122) section. For the driver-specific list, see your *driver documentation* (page 435).

The following example in the `mongo` (page 908) shell adds the `DBQuery.Option.tailable` flag and the `DBQuery.Option.awaitData` flag to ensure that the query returns a tailable cursor:

```
var t = db.myCappedCollection;
var cursor = t.find().addOption(DBQuery.Option.tailable).
                      addOption(DBQuery.Option.awaitData)
```

This sequence of operations creates a cursor that will wait for few seconds after returning the full result set so that it can capture and return additional data added during the query.

Warning: Adding incorrect wire protocol flags can cause problems and/or extra server load.

cursor.batchSize()

`cursor.batchSize()`

The `batchSize()` (page 804) method specifies the number of documents to return in each batch of the response from the MongoDB instance. In most cases, modifying the batch size will not affect the user or the application since the `mongo` (page 908) shell and most *drivers* (page 435) return results as if MongoDB returned a single batch.

The `batchSize()` (page 804) method takes the following parameter:

Parameters

- **size** – The number of documents to return per batch. Do **not** use a batch size of `1`.

Note: Specifying `1` or a negative number is analogous to using the `limit()` (page 807) method.

Consider the following example of the `batchSize()` (page 804) method in the `mongo` (page 908) shell:

```
db.inventory.find().batchSize(10)
```

This operation will set the batch size for the results of a query (i.e. `find()` (page 820)) to `10`. The effects of this operation do not affect the output in the `mongo` (page 908) shell, which always iterates over the first 20 documents.

cursor.count()

`cursor.count()`

The `count()` (page 804) method counts the number of documents referenced by a cursor. Append the `count()` (page 804) method to a `find()` (page 820) query to return the number of matching documents, as in the following prototype:

```
db.collection.find().count()
```

This operation does not actually perform the `find()` (page 820); instead, the operation counts the results that would be returned by the `find()` (page 820).

The `count()` (page 804) can accept the following argument:

Parameters

- **applySkipLimit** (*boolean*) – Optional. Specifies whether to consider the effects of the `cursor.skip()` (page 812) and `cursor.limit()` (page 807) methods in the count. By default, the `count()` (page 804) method ignores the effects of the `cursor.skip()` (page 812) and `cursor.limit()` (page 807). Set `applySkipLimit` to `true` to consider the effect of these methods.

  See Also:

  `cursor.size()` (page 812)

MongoDB also provides the shell wrapper `db.collection.count()` (page 816) for the `db.collection.find().count()` construct.

Consider the following examples of the `count()` (page 804) method:

- Count the number of all documents in the `orders` collection:

```
db.orders.find().count()
```

- Count the number of the documents in the `orders` collection with the field `ord_dt` greater than `new Date('01/01/2012')`:

```
db.orders.find( { ord_dt: { $gt: new Date('01/01/2012') } } ).count()
```

- Count the number of the documents in the `orders` collection with the field `ord_dt` greater than `new Date('01/01/2012')` *taking into account* the effect of the `limit(5)`:

```
db.orders.find( { ord_dt: { $gt: new Date('01/01/2012') } } ).limit(5).count(true)
```

cursor.explain()

`cursor.explain()`

The `cursor.explain()` (page 805) method provides information on the query plan. The query plan is the plan the server uses to find the matches for a query. This information may be useful when optimizing a query.

Parameters

- **verbose** (*boolean*) – Specifies the level of detail to include in the output. If `true` or `1`, include the `allPlans` and `oldPlan` fields in the *output document* (page 1006).

Returns A *document* (page 1006) that describes the process used to return the query results.

Retrieve the query plan by appending `explain()` (page 805) to a `find()` (page 820) query, as in the following example:

```
db.products.find().explain()
```

For details on the output, see *Explain Output* (page 1006).

`explain` (page 805) runs the actual query to determine the result. Although there are some differences between running the query with `explain` (page 805) and running without, generally, the performance will be similar between the two. So, if the query is slow, the `explain` (page 805) operation is also slow.

Additionally, the `explain` (page 805) operation reevaluates a set of candidate query plans, which may cause the `explain` (page 805) operation to perform differently than a normal query. As a result, these operations generally provide an accurate account of *how* MongoDB would perform the query, but do not reflect the length of these queries.

To determine the performance of a particular index, you can use `hint()` (page 806) and in conjunction with `explain()` (page 805), as in the following example:

```
db.products.find().hint( { type: 1 } ).explain()
```

When you run `explain` (page 805) with `hint()` (page 806), the query optimizer does not reevaluate the query plans.

Note: In some situations, the `explain()` (page 805) operation may differ from the actual query plan used by MongoDB in a normal query.

The `explain()` (page 805) operation evaluates the set of query plans and reports on the winning plan for the query. In normal operations the query optimizer caches winning query plans and uses them for similar related

queries in the future. As a result MongoDB may sometimes select query plans from the cache that are different from the plan displayed using `explain` (page 805).

See Also:

- `$explain` (page 696)
- *Optimization Strategies for MongoDB Applications* (page 435) page for information regarding optimization strategies.
- *Analyze Performance of Database Operations* (page 616) tutorial for information regarding the database profile.
- *Current Operation Reporting* (page 998)

cursor.forEach()

`cursor.forEach(`*<function>*`)`

The `forEach()` (page 806) method iterates the cursor to apply a JavaScript `<function>` to each document from the cursor.

The `forEach()` (page 806) method accepts the following argument:

Parameters

- **<function>** – JavaScript function to apply to each document from the cursor. The `<function>` signature includes a single argument that is passed the current document to process.

The following example invokes the `forEach()` (page 806) method on the cursor returned by `find()` (page 820) to print the name of each user in the collection:

```
db.users.find().forEach( function(myDoc) { print( "user: " + myDoc.name ); } );
```

See Also:

`cursor.map()` (page 807) for similar functionality.

cursor.hasNext()

`cursor.hasNext()`

Returns Boolean.

`cursor.hasNext()` (page 806) returns `true` if the cursor returned by the `db.collection.find()` (page 820) query can iterate further to return more documents.

cursor.hint()

`cursor.hint(`*index*`)`

Arguments

- **index** – The index to "hint" or force MongoDB to use when performing the query.

  Specify the index either by the index name or by the index specification document. See *Index Specification Documents* (page 140) for information on index specification documents.

Call this method on a query to override MongoDB's default index selection and query optimization process. Use `db.collection.getIndexes()` (page 826) to return the list of current indexes on a collection.

Consider the following operation:

```
db.users.find().hint( { age: 1 } )
```

This operation returns all documents in the collection named `users` using the index on the `age` field.

You can also specify the index using the index name:

```
db.users.find().hint( "age_1" )
```

See Also:

`$hint` (page 698)

cursor.limit()

`cursor.limit()`

Use the `cursor.limit()` (page 807) method on a cursor to specify the maximum number of documents a the cursor will return. `cursor.limit()` (page 807) is analogous to the `LIMIT` statement in a SQL database.

Note: You must apply `cursor.limit()` (page 807) to the cursor before retrieving any documents from the database.

Use `cursor.limit()` (page 807) to maximize performance and prevent MongoDB from returning more results than required for processing.

A `cursor.limit()` (page 807) value of 0 (e.g. "`.limit(0)` (page 807)") is equivalent to setting no limit.

cursor.map()

`cursor.map(`*function*`)`

Parameters

- **function** – function to apply to each document visited by the cursor.

Apply *function* to each document visited by the cursor, and collect the return values from successive application into an array. Consider the following example:

```
db.users.find().map( function(u) { return u.name; } );
```

See Also:

`cursor.forEach()` (page 806) for similar functionality.

cursor.max()

`cursor.max()`

The `max()` (page 807) method specifies the *exclusive* upper bound for a specific index in order to constrain the results of `find()` (page 820). `max()` (page 807) provides a way to specify an upper bound on compound key indexes.

`max()` (page 807) takes the following parameter:

Parameters

- **indexBounds** (*document*) – Specifies the exclusive upper bound for the index keys. The `indexBounds` parameter has the following prototype form:

  ```
  { field1: <max value>, field2: <max value2> ... fieldN:<max valueN>}
  ```

  The fields correspond to *all* the keys of a particular index *in order*. You can explicitly specify the particular index with the `hint()` (page 806) method. Otherwise, `mongod` (page 897) selects the index using the fields in the `indexBounds`; however, if multiple indexes exist on same fields with different sort orders, the selection of the index may be ambiguous.

See Also:

`min()` (page 809).

Consider the following example of `max()` (page 807), which assumes a collection named `products` that holds the following documents:

```
{ "_id" : 6, "item" : "apple", "type" : "cortland", "price" : 1.29 }
{ "_id" : 2, "item" : "apple", "type" : "fuji", "price" : 1.99 }
{ "_id" : 1, "item" : "apple", "type" : "honey crisp", "price" : 1.99 }
{ "_id" : 3, "item" : "apple", "type" : "jonagold", "price" : 1.29 }
{ "_id" : 4, "item" : "apple", "type" : "jonathan", "price" : 1.29 }
{ "_id" : 5, "item" : "apple", "type" : "mcintosh", "price" : 1.29 }
{ "_id" : 7, "item" : "orange", "type" : "cara cara", "price" : 2.99 }
{ "_id" : 10, "item" : "orange", "type" : "navel", "price" : 1.39 }
{ "_id" : 9, "item" : "orange", "type" : "satsuma", "price" : 1.99 }
{ "_id" : 8, "item" : "orange", "type" : "valencia", "price" : 0.99 }
```

The collection has the following indexes:

```
{ "_id" : 1 }
{ "item" : 1, "type" : 1 }
{ "item" : 1, "type" : -1 }
{ "price" : 1 }
```

- Using the ordering of `{ item: 1, type: 1 }` index, `max()` (page 807) limits the query to the documents that are below the bound of `item` equal to `apple` and `type` equal to `jonagold`:

  ```
  db.products.find().max( { item: 'apple', type: 'jonagold' } ).hint( { item: 1, type: 1 } )
  ```

  The query returns the following documents:

  ```
  { "_id" : 6, "item" : "apple", "type" : "cortland", "price" : 1.29 }
  { "_id" : 2, "item" : "apple", "type" : "fuji", "price" : 1.99 }
  { "_id" : 1, "item" : "apple", "type" : "honey crisp", "price" : 1.99 }
  ```

  If the query did not explicitly specify the index with the `hint()` (page 806) method, it is ambiguous as to whether `mongod` (page 897) would select the `{ item: 1, type: 1 }` index ordering or the `{ item: 1, type: -1 }` index ordering.

- Using the ordering of the index `{ price: 1 }`, `max()` (page 807) limits the query to the documents that are below the index key bound of `price` equal to `1.99` and `min()` (page 809) limits the query to the documents that are at or above the index key bound of `price` equal to `1.39`:

  ```
  db.products.find().min( { price: 1.39 } ).max( { price: 1.99 } ).hint( { price: 1 } )
  ```

  The query returns the following documents:

```
{ "_id" : 6, "item" : "apple", "type" : "cortland", "price" : 1.29 }
{ "_id" : 4, "item" : "apple", "type" : "jonathan", "price" : 1.29 }
{ "_id" : 5, "item" : "apple", "type" : "mcintosh", "price" : 1.29 }
{ "_id" : 3, "item" : "apple", "type" : "jonagold", "price" : 1.29 }
{ "_id" : 10, "item" : "orange", "type" : "navel", "price" : 1.39 }
```

Note:

- Because `max()` (page 807) requires an index on a field, and forces the query to use this index, you may prefer the `$lt` (page 700) operator for the query if possible. Consider the following example:

  ```
  db.products.find( { _id: 7 } ).max( { price: 1.39 } )
  ```

  The query will use the index on the `price` field, even if the index on `_id` may be better.

- `max()` (page 807) exists primarily to support the `mongos` (page 905) (sharding) process.
- If you use `max()` (page 807) with `min()` (page 809) to specify a range, the index bounds specified in `min()` (page 809) and `max()` (page 807) must both refer to the keys of the same index.
- `max()` (page 807) is a shell wrapper around the special operator `$max` (page 701).

---

cursor.min()

`cursor.min()`

The `min()` (page 809) method specifies the *inclusive* lower bound for a specific index in order to constrain the results of `find()` (page 820). `min()` (page 809) provides a way to specify lower bounds on compound key indexes.

`min()` (page 809) takes the following parameter:

Parameters

- **indexBounds** (*document*) – Specifies the inclusive lower bound for the index keys. The `indexBounds` parameter has the following prototype form:

  ```
  { field1: <min value>, field2: <min value2>, fieldN:<min valueN> }
  ```

  The fields correspond to *all* the keys of a particular index *in order*. You can explicitly specify the particular index with the `hint()` (page 806) method. Otherwise, MongoDB selects the index using the fields in the `indexBounds`; however, if multiple indexes exist on same fields with different sort orders, the selection of the index may be ambiguous.

See Also:

`max()` (page 807).

Consider the following example of `min()` (page 809), which assumes a collection named `products` that holds the following documents:

```
{ "_id" : 6, "item" : "apple", "type" : "cortland", "price" : 1.29 }
{ "_id" : 2, "item" : "apple", "type" : "fuji", "price" : 1.99 }
{ "_id" : 1, "item" : "apple", "type" : "honey crisp", "price" : 1.99 }
{ "_id" : 3, "item" : "apple", "type" : "jonagold", "price" : 1.29 }
{ "_id" : 4, "item" : "apple", "type" : "jonathan", "price" : 1.29 }
{ "_id" : 5, "item" : "apple", "type" : "mcintosh", "price" : 1.29 }
{ "_id" : 7, "item" : "orange", "type" : "cara cara", "price" : 2.99 }
{ "_id" : 10, "item" : "orange", "type" : "navel", "price" : 1.39 }
```

```
{ "_id" : 9, "item" : "orange", "type" : "satsuma", "price" : 1.99 }
{ "_id" : 8, "item" : "orange", "type" : "valencia", "price" : 0.99 }
```

The collection has the following indexes:

```
{ "_id" : 1 }
{ "item" : 1, "type" : 1 }
{ "item" : 1, "type" : -1 }
{ "price" : 1 }
```

- Using the ordering of `{ item: 1, type: 1 }` index, `min()` (page 809) limits the query to the documents that are at or above the index key bound of `item` equal to `apple` and `type` equal to `jonagold`, as in the following:

  ```
  db.products.find().min( { item: 'apple', type: 'jonagold' } ).hint( { item: 1, type: 1 } )
  ```

  The query returns the following documents:

  ```
  { "_id" : 3, "item" : "apple", "type" : "jonagold", "price" : 1.29 }
  { "_id" : 4, "item" : "apple", "type" : "jonathan", "price" : 1.29 }
  { "_id" : 5, "item" : "apple", "type" : "mcintosh", "price" : 1.29 }
  { "_id" : 7, "item" : "orange", "type" : "cara cara", "price" : 2.99 }
  { "_id" : 10, "item" : "orange", "type" : "navel", "price" : 1.39 }
  { "_id" : 9, "item" : "orange", "type" : "satsuma", "price" : 1.99 }
  { "_id" : 8, "item" : "orange", "type" : "valencia", "price" : 0.99 }
  ```

  If the query did not explicitly specify the index with the `hint()` (page 806) method, it is ambiguous as to whether `mongod` (page 897) would select the `{ item: 1, type: 1 }` index ordering or the `{ item: 1, type: -1 }` index ordering.

- Using the ordering of the index `{ price: 1 }`, `min()` (page 809) limits the query to the documents that are at or above the index key bound of `price` equal to `1.39` and `max()` (page 807) limits the query to the documents that are below the index key bound of `price` equal to `1.99`:

  ```
  db.products.find().min( { price: 1.39 } ).max( { price: 1.99 } ).hint( { price: 1 } )
  ```

  The query returns the following documents:

  ```
  { "_id" : 6, "item" : "apple", "type" : "cortland", "price" : 1.29 }
  { "_id" : 4, "item" : "apple", "type" : "jonathan", "price" : 1.29 }
  { "_id" : 5, "item" : "apple", "type" : "mcintosh", "price" : 1.29 }
  { "_id" : 3, "item" : "apple", "type" : "jonagold", "price" : 1.29 }
  { "_id" : 10, "item" : "orange", "type" : "navel", "price" : 1.39 }
  ```

Note:

- Because `min()` (page 809) requires an index on a field, and forces the query to use this index, you may prefer the `$gte` (page 697) operator for the query if possible. Consider the following example:

  ```
  db.products.find( { _id: 7 } ).min( { price: 1.39 } )
  ```

  The query will use the index on the `price` field, even if the index on `_id` may be better.

- `min()` (page 809) exists primarily to support the `mongos` (page 905) (sharding) process.

- If you use `min()` (page 809) with `max()` (page 807) to specify a range, the index bounds specified in `min()` (page 809) and `max()` (page 807) must both refer to the keys of the same index.

- `min()` (page 809) is a shell wrapper around the special operator `$min` (page 702).

---

cursor.next()

`cursor.next()`

Returns The next document in the cursor returned by the `db.collection.find()` (page 820) method. See `cursor.hasNext()` (page 806) related functionality.

cursor.objsLeftInBatch()

`cursor.objsLeftInBatch()`

`cursor.objsLeftInBatch()` (page 811) returns the number of documents remaining in the current batch.

The MongoDB instance returns response in batches. To retrieve all the documents from a cursor may require multiple batch responses from the MongoDB instance. When there are no more documents remaining in the current batch, the cursor will retrieve another batch to get more documents until the cursor exhausts.

cursor.readPref()

`cursor.readPref()`

Parameters

- **mode** (*string*) – Read preference mode
- **tagSet** (*array*) – Optional. Array of tag set objects

Append the `readPref()` (page 811) to a cursor to control how the client will route the query will route to members of the replica set.

The `mode` string should be one of:

- `primary` (page 307)
- `primaryPreferred` (page 307)
- `secondary` (page 307)
- `secondaryPreferred` (page 307)
- `nearest` (page 308)

The `tagSet` parameter, if given, should consist of an array of tag set objects for filtering secondary read operations. For example, a secondary member tagged `{ dc: 'ny', rack: 2, size: 'large' }` will match the tag set `{ dc: 'ny', rack: 2 }`. Clients match tag sets first in the order they appear in the read preference specification. You may specify an empty tag set `{}` as the last element to default to any available secondary. See the *tag sets* (page 308) documentation for more information.

Note: You must apply `cursor.readPref()` (page 811) to the cursor before retrieving any documents from the database.

---

cursor.showDiskLoc()

`cursor.showDiskLoc()`

Returns A modified cursor object that contains documents with appended information that describes the on-disk location of the document.

See Also:

$showDiskLoc (page 717) for related functionality.

cursor.size()

cursor.**size**()

Returns A count of the number of documents that match the db.collection.find() (page 820) query after applying any cursor.skip() (page 812) and cursor.limit() (page 807) methods.

cursor.skip()

cursor.**skip**()

Call the cursor.skip() (page 812) method on a cursor to control where MongoDB begins returning results. This approach may be useful in implementing "paged" results.

Note: You must apply cursor.skip() (page 812) to the cursor before retrieving any documents from the database.

Consider the following JavaScript function as an example of the sort function:

```
function printStudents(pageNumber, nPerPage) {
   print("Page: " + pageNumber);
   db.students.find().skip((pageNumber-1)*nPerPage).limit(nPerPage).forEach( function(student) {
}
```

The cursor.skip() (page 812) method is often expensive because it requires the server to walk from the beginning of the collection or index to get the offset or skip position before beginning to return result. As offset (e.g. pageNumber above) increases, cursor.skip() (page 812) will become slower and more CPU intensive. With larger collections, cursor.skip() (page 812) may become IO bound.

Consider using range-based pagination for these kinds of tasks. That is, query for a range of objects, using logic within the application to determine the pagination rather than the database itself. This approach features better index utilization, if you do not need to easily jump to a specific page.

cursor.snapshot()

cursor.**snapshot**()

Append the cursor.snapshot() (page 812) method to a cursor to toggle the "snapshot" mode. This ensures that the query will not return a document multiple times, even if intervening write operations result in a move of the document due to the growth in document size.

Warning:

- You must apply cursor.snapshot() (page 812) to the cursor before retrieving any documents from the database.
- You can only use snapshot() (page 812) with **unsharded** collections.

The snapshot() (page 812) does not guarantee isolation from insertion or deletions.

The cursor.snapshot() (page 812) traverses the index on the _id field. As such, snapshot() (page 812) **cannot** be used with sort() (page 813) or hint() (page 806).

Queries with results of less than 1 megabyte are effectively implicitly snapshotted.

cursor.sort()

`cursor.sort(sort)`

Parameters

- **sort** – A document whose fields specify the attributes on which to sort the result set.

Append the `sort()` (page 813) method to a cursor to control the order that the query returns matching documents. For each field in the sort document, if the field's corresponding value is positive, then `sort()` (page 813) returns query results in ascending order for that attribute: if the field's corresponding value is negative, then `sort()` (page 813) returns query results in descending order.

Note: You must apply `cursor.limit()` (page 807) to the cursor before retrieving any documents from the database.

Consider the following example:

```
db.collection.find().sort( { age: -1 } );
```

Here, the query returns all documents in `collection` sorted by the `age` field in descending order. Specify a value of negative one (e.g. `-1`), as above, to sort in descending order or a positive value (e.g. `1`) to sort in ascending order.

Unless you have a index for the specified key pattern, use `cursor.sort()` (page 813) in conjunction with `cursor.limit()` (page 807) to avoid requiring MongoDB to perform a large, in-memory sort. `cursor.limit()` (page 807) increases the speed and reduces the amount of memory required to return this query by way of an optimized algorithm.

Warning: The sort function requires that the entire sort be able to complete within 32 megabytes. When the sort option consumes more than 32 megabytes, MongoDB will return an error. Use `cursor.limit()` (page 807), or create an index on the field that you're sorting to avoid this error.

The `$natural` (page 704) parameter returns items according to their order on disk. Consider the following query:

```
db.collection.find().sort( { $natural: -1 } )
```

This will return documents in the reverse of the order on disk. Typically, the order of documents on disks reflects insertion order, *except* when documents move internal because of document growth due to update operations.

When comparing values of different *BSON* types, MongoDB uses the following comparison order, from lowest to highest:

1. MinKey (internal type)
2. Null
3. Numbers (ints, longs, doubles)
4. Symbol, String
5. Object
6. Array
7. BinData

8. ObjectID
9. Boolean
10. Date, Timestamp
11. Regular Expression
12. MaxKey (internal type)

Note: MongoDB treats some types as equivalent for comparison purposes. For instance, numeric types undergo conversion before comparison.

cursor.toArray()

`cursor.toArray()`

The `toArray()` (page 814) method returns an array that contains all the documents from a cursor. The method iterates completely the cursor, loading all the documents into RAM and exhausting the cursor.

Returns An array of documents.

Consider the following example that applies `toArray()` (page 814) to the cursor returned from the `find()` (page 820) method:

```
var allProductsArray = db.products.find().toArray();

if (allProductsArray.length > 0) { printjson (allProductsArray[0]); }
```

The variable `allProductsArray` holds the array of documents returned by `toArray()` (page 814).

db.addUser()

`db.addUser(`*"username"*, *"password"*[, *readOnly*]`)`

Parameters

- **username** (*string*) – Specifies a new username.
- **password** (*string*) – Specifies the corresponding password.
- **readOnly** (*boolean*) – Optional. Restrict a user to read-privileges only. Defaults to false.

Use this function to create new database users, by specifying a username and password as arguments to the command. If you want to restrict the user to have only read-only privileges, supply a true third argument; however, this defaults to false.

For example:

```
db.addUser("user1" , "pass" , { readOnly : true } )
```

db.auth()

`db.auth(`*"username"*, *"password"*`)`

Parameters

- **username** (*string*) – Specifies an existing username with access privileges for this database.
- **password** (*string*) – Specifies the corresponding password.

Allows a user to authenticate to the database from within the shell. Alternatively use *mongo --username* (page 909) and *--password* (page 909) to specify authentication credentials.

db.cloneCollection()

db.**cloneCollection**(*from*, *collection*, *query*)

db.cloneCollection() (page 815) provides a wrapper around cloneCollection (page 743) for copying data directly between MongoDB instances. db.cloneCollection() (page 815) does not allow you to clone a collection through a mongos (page 905): you must connect directly to the mongod (page 897) instance.

Parameters

- **from** (*string*) – A host name, of the MongoDB instance that holds the collection you wish to copy
- **collection** (*string*) – A collection in the MongoDB instance that you want to copy. db.cloneCollection() (page 815) will only copy the collection with this name from *database* of the same name as the current database the remote MongoDB instance. If you want to copy a collection from a different database name you must use the cloneCollection (page 743) directly.
- **query** (*document*) – Optional. A standard *MongoDB query document* (page 139) to limit the documents copied as part of the db.cloneCollection() (page 815) operation.

db.cloneDatabase()

db.**cloneDatabase**(*"hostname"*)

Parameters

- **hostname** (*string*) – Specifies the hostname to copy the current instance.

Use this function to copy a database from a remote to the current database. The command assumes that the remote database has the same name as the current database. For example, to clone a database named importdb on a host named hostname, do

```
use importdb
db.cloneDatabase("hostname");
```

New databases are implicitly created, so the current host does not need to have a database named importdb for this command to succeed.

This function provides a wrapper around the MongoDB *database command* "clone (page 743)." The copydb (page 749) database command provides related functionality.

db.collection.aggregate()

db.collection.**aggregate**(*pipeline*)

New in version 2.2. Always call the db.collection.aggregate() (page 815) method on a collection object.

Arguments

- **pipeline** – Specifies a sequence of data aggregation processes. See the *aggregation reference* (page 211) for documentation of these operators.

Consider the following example from the *aggregation documentation* (page 195).

```
db.article.aggregate(
  { $project : {
     author : 1,
     tags : 1,
  } },
  { $unwind : "$tags" },
  { $group : {
     _id : { tags : 1 },
     authors : { $addToSet : "$author" }
  } }
);
```

See Also:

"aggregate (page 740)," "*Aggregation Framework* (page 195)," and "*Aggregation Framework Reference* (page 211)."

db.collection.count()

db.collection.**count**()

The db.collection.count() (page 816) method is a shell wrapper that returns the count of documents that would match a find() (page 820) query; i.e., db.collection.count() (page 816) method is equivalent to:

```
db.collection.find(<query>).count();
```

This operation does not actually perform the find() (page 820); instead, the operation counts the results that would be returned by the find() (page 820).

The db.collection.count() (page 816) method can accept the following argument:

Parameters

- **query** (*document*) – Specifies the selection query criteria.

Consider the following examples of the db.collection.count() (page 816) method

•Count the number of all documents in the orders collection:

```
db.orders.count()
```

The query is equivalent to the following:

```
db.orders.find().count()
```

•Count the number of the documents in the orders collection with the field ord_dt greater than new Date('01/01/2012'):

```
db.orders.count( { ord_dt: { $gt: new Date('01/01/2012') } } )
```

The query is equivalent to the following:

```
db.orders.find( { ord_dt: { $gt: new Date('01/01/2012') } } ).count()
```

See Also:

cursor.count() (page 804)

db.collection.createIndex()

db.collection.**createIndex**(*keys*, *options*)

Deprecated since version 1.8.

Parameters

- **keys** (*document*) – A *document* that contains pairs with the name of the field or fields to index and order of the index. A `1` specifies ascending and a `-1` specifies descending.
- **options** (*document*) – A *document* that controls the creation of the index. This argument is optional.

The `ensureIndex()` (page 819) method is the preferred way to create indexes on collections.

See Also:

Indexes (page 239), `db.collection.createIndex()` (page 817), `db.collection.dropIndex()` (page 818), `db.collection.dropIndexes()` (page 819), `db.collection.getIndexes()` (page 826), `db.collection.reIndex()` (page 838), and `db.collection.totalIndexSize()` (page 842)

db.collection.dataSize()

db.collection.**dataSize**()

Returns The size of the collection. This method provides a wrapper around the `size` (page 981) output of the `collStats` (page 745) (i.e. `db.collection.stats()` (page 841)) command.

db.collection.distinct()

db.collection.**distinct**()

The `db.collection.distinct()` (page 817) method finds the distinct values for a specified field across a single collection and returns the results in an array. The method accepts the following argument:

Parameters

- **field** (*string*) – Specifies the field for which to return the distinct values.
- **query** (*document*) – Specifies the selection `query` to determine the subset of documents from which to retrieve the distinct values.

Note:

- The `db.collection.distinct()` (page 817) method provides a wrapper around the `distinct` (page 753) command. Results must not be larger than the maximum *BSON size* (page 1021).
- When possible to use covered indexes, the `db.collection.distinct()` (page 817) method will use an index to find the documents in the query as well as to return the data.

Consider the following examples of the `db.collection.distinct()` (page 817) method:

- Return an array of the distinct values of the field `ord_dt` from all documents in the `orders` collection:

```
db.orders.distinct( 'ord_dt' )
```

- Return an array of the distinct values of the field `sku` in the subdocument `item` from all documents in the `orders` collection:

```
db.orders.distinct( 'item.sku' )
```

- Return an array of the distinct values of the field `ord_dt` from the documents in the `orders` collection where the `price` is greater than `10`:

```
db.orders.distinct( 'ord_dt',
                    { price: { $gt: 10 } }
                  )
```

db.collection.drop()

`db.collection.`**`drop`**`()`

Call the `db.collection.drop()` (page 818) method on a collection to drop it from the database.

`db.collection.drop()` (page 818) takes no arguments and will produce an error if called with any arguments.

db.collection.dropIndex()

`db.collection.`**`dropIndex`**`(`*index*`)`

Drops or removes the specified index from a collection. The `db.collection.dropIndex()` (page 818) method provides a wrapper around the `dropIndexes` (page 755) command.

The `db.collection.dropIndex()` (page 818) method takes the following parameter:

Parameters

- **index** – Specifies either the name or the key of the index to drop. You **must** use the name of the index if you specified a name during the index creation.

The `db.collection.dropIndex()` (page 818) method cannot drop the `_id` index. Use the `db.collection.getIndexes()` (page 826) method to view all indexes on a collection.

Consider the following examples of the `db.collection.dropIndex()` (page 818) method that assumes the following indexes on the collection `pets`:

```
> db.pets.getIndexes()
[
   {  "v" : 1,
      "key" : { "_id" : 1 },
      "ns" : "test.pets",
      "name" : "_id_"
   },
   {
      "v" : 1,
      "key" : { "cat" : -1 },
      "ns" : "test.pets",
      "name" : "catIdx"
   },
   {
      "v" : 1,
      "key" : { "cat" : 1, "dog" : -1 },
      "ns" : "test.pets",
      "name" : "cat_1_dog_-1"
   }
]
```

- To drop the index on the field `cat`, you must use the index name `catIdx`:

```
db.pets.dropIndex( 'catIdx' )
```

- To drop the index on the fields `cat` and `dog`, you use either the index name `cat_1_dog_-1` or the key `{ "cat" : 1, "dog" : -1 }`:

```
db.pets.dropIndex( 'cat_1_dog_-1' )
```

```
db.pets.dropIndex( { cat : 1, dog : -1 } )
```

db.collection.dropIndexes()

`db.collection.`**`dropIndexes`**`()`

Drops all indexes other than the required index on the `_id` field. Only call `dropIndexes()` (page 819) as a method on a collection object.

db.collection.ensureIndex()

`db.collection.`**`ensureIndex`**`(`*keys*, *options*`)`

Creates an index on the field specified, if that index does not already exist.

Parameters

- **keys** (*document*) – A *document* that contains pairs with the name of the field or fields to index and order of the index. A `1` specifies ascending and a `-1` specifies descending.
- **options** (*document*) – A *document* that controls the creation of the index. This argument is optional.

Warning: Index names, including their full namespace (i.e. `database.collection`) can be no longer than 128 characters. See the `db.collection.getIndexes()` (page 826) field "`name` (page 826)" for the names of existing indexes.

Consider the following prototype:

```
db.collection.ensureIndex({ <key>: 1})
```

This command creates an index, in ascending order, on the field `[key]`.

If the `keys` document specifies more than one field, than `db.collection.ensureIndex()` (page 819) creates a *compound index*. To specify a compound index use the following form:

```
db.collection.ensureIndex({ <key>: 1, <key1>: -1 })
```

This command creates a compound index on the `key` field (in ascending order) and `key1` field (in descending order.)

Note: The order of an index is important for supporting `cursor.sort()` (page 813) operations using the index.

The *Indexes* (page 239) section of this manual for full documentation of indexes and indexing in MongoDB.

`ensureIndex()` (page 819) provides the following options

Option	Value	Default
background	`true` or `false`	`false`
unique	`true` or `false`	`false`
name	string	none
dropDups	`true` or `false`	`false`
sparse	`true` or `false`	`false`
expireAfterSeconds	integer	none
v	index version	1

Options

- **background** (*boolean*) – Specify `true` to build the index in the background so that building an index will *not* block other database activities.
- **unique** (*boolean*) – Specify `true` to create a unique index so that the collection will not accept insertion of documents where the index key or keys matches an existing value in the index.
- **name** (*string*) – Specify the name of the index. If unspecified, MongoDB will generate an index name by concatenating the names of the indexed fields and the sort order.
- **dropDups** (*boolean*) – Specify `true` when creating a unique index, on a field that *may* have duplicate to index only the first occurrence of a key, and **remove** all documents from the collection that contain subsequent occurrences of that key.
- **sparse** (*boolean*) – If `true`, the index only references documents with the specified field. These indexes use less space, but behave differently in some situations (particularly sorts.)
- **expireAfterSeconds** (*integer*) – Specify a value, in seconds, as a *TTL* to control how long MongoDB will retain documents in this collection. See "*Expire Data from Collections by Setting TTL* (page 458)" for more information on this functionality.
- **v** – Only specify a different index version in unusual situations. The latest index version (version 1) provides a smaller and faster index format.

Please be aware of the following behaviors of `ensureIndex()` (page 819):

•To add or change index options you must drop the index using the `dropIndex()` (page 818) method and issue another `ensureIndex()` (page 819) operation with the new options.

If you create an index with one set of options, and then issue the `ensureIndex()` (page 819) method with the same index fields and different options without first dropping the index, `ensureIndex()` (page 819) will *not* rebuild the existing index with the new options.

•If you call multiple `ensureIndex()` (page 819) methods with the same index specification at the same time, only the first operation will succeed, all other operations will have no effect.

•Non-background indexing operations will block all other operations on a database.

•You cannot stop a foreground index build once it's begun. See the *Monitor and Control Index Building* (page 256) for more information.

db.collection.find()

`db.collection.`**`find`**(*query*, *projection*)

The `find()` (page 820) method selects documents in a collection and returns a *cursor* to the selected documents.

The `find()` (page 820) method takes the following parameters.

Parameters

- **query** (*document*) – Optional. Specifies the selection criteria using *query operators* (page 882). Omit the `query` parameter or pass an empty document (e.g. `{}`) to return all documents in the collection.
- **projection** (*document*) – Optional. Controls the fields to return, or the *projection*. The `projection` argument will resemble the following prototype:

  ```
  { field1: boolean, field2: boolean ... }
  ```

  The `boolean` can take the following include or exclude values:

  – `1` or `true` to include. The `find()` (page 820) method always includes the *_id* field even if the field is not explicitly stated to return in the *projection* parameter.

  – `0` or `false` to exclude.

  The `projection` cannot contain both include and exclude specifications except for the exclusion of the `_id` field.

  Omit the `projection` parameter to return **all** the fields in the matching documents.

Returns A *cursor* to the documents that match the `query` criteria. If the `projection` argument is specified, the matching documents contain only the `projection` fields, and the `_id` field if you do not explicitly exclude the `_id` field.

Note: In the `mongo` (page 908) shell, you can access the returned documents directly without explicitly using the JavaScript cursor handling method. Executing the query directly on the `mongo` (page 908) shell prompt automatically iterates the cursor to display up to the first 20 documents. Type `it` to continue iteration.

Consider the following examples of the `find()` (page 820) method:

•To select all documents in a collection, call the `find()` (page 820) method with no parameters:

```
db.products.find()
```

This operation returns all the documents with all the fields from the collection `products`. By default, in the `mongo` (page 908) shell, the cursor returns the first batch of 20 matching documents. In the `mongo` (page 908) shell, iterate through the next batch by typing `it`. Use the appropriate cursor handling mechanism for your specific language driver.

•To select the documents that match a selection criteria, call the `find()` (page 820) method with the `query` criteria:

```
db.products.find( { qty: { $gt: 25 } } )
```

This operation returns all the documents from the collection `products` where `qty` is greater than `25`, including all fields.

•To select the documents that match a selection criteria and return, or *project* only certain fields into the result set, call the `find()` (page 820) method with the `query` criteria and the `projection` parameter, as in the following example:

```
db.products.find( { qty: { $gt: 25 } }, { item: 1, qty: 1 } )
```

This operation returns all the documents from the collection `products` where `qty` is greater than `25`. The documents in the result set only include the `_id`, `item`, and `qty` fields using "inclusion" projection. `find()` (page 820) always returns the `_id` field, even when not explicitly included:

```
{ "_id" : 11, "item" : "pencil", "qty" : 50 }
{ "_id" : ObjectId("50634d86be4617f17bb159cd"), "item" : "bottle", "qty" : 30 }
{ "_id" : ObjectId("50634dbcbe4617f17bb159d0"), "item" : "paper", "qty" : 100 }
```

- To select the documents that match a query criteria and exclude a set of fields from the resulting documents, call the `find()` (page 820) method with the `query` criteria and the `projection` parameter using the `exclude` syntax:

```
db.products.find( { qty: { $gt: 25 } }, { _id: 0, qty: 0 } )
```

The query will return all the documents from the collection `products` where `qty` is greater than `25`. The documents in the result set will contain all fields *except* the `_id` and `qty` fields, as in the following:

```
{ "item" : "pencil", "type" : "no.2" }
{ "item" : "bottle", "type" : "blue" }
{ "item" : "paper" }
```

db.collection.findAndModify()

db.collection.**findAndModify**()

The `findAndModify()` (page 822) method atomically modifies and returns a single document. By default, the returned document does not include the modifications made on the update. To return the document with the modifications made on the update, use the `new` option. The `findAndModify()` (page 822) method is a shell helper around the `findAndModify` (page 758) command.

```
db.collection.findAndModify( {
                                query: <document>,
                                sort: <document>,
                                remove: <boolean>,
                                update: <document>,
                                new: <boolean>,
                                fields: <document>,
                                upsert: <boolean>
                              } );
```

The `db.collection.findAndModify()` (page 822) method takes a document parameter with the following subdocument fields:

Fields

- **query** (*document*) – Optional. Specifies the selection criteria for the modification. The `query` field employs the same *query selectors* (page 882) as used in the `db.collection.find()` (page 820) method. Although the query may match multiple documents, `findAndModify()` (page 822) will only select one document to modify.
- **sort** (*document*) – Optional. Determines which document the operation will modify if the query selects multiple documents. `findAndModify()` (page 822) will modify the first document in the sort order specified by this argument.
- **remove** (*boolean*) – Optional if `update` field exists. When `true`, removes the selected document. The default is `false`.
- **update** (*document*) – Optional if `remove` field exists. Performs an update of the selected document. The `update` field employs the same *update operators* (page 884) or `field: value` specifications to modify the selected document.
- **new** (*boolean*) – Optional. When `true`, returns the modified document rather than the original. The `findAndModify()` (page 822) method ignores the `new` option for `remove` operations. The default is `false`.

- **fields** (*document*) – Optional. A subset of fields to return. The `fields` document specifies an inclusion of a field with `1`, as in the following:

  ```
  fields: { <field1>: 1, <field2>: 1, ... }
  ```

  See *projection* (page 115).

- **upsert** (*boolean*) – Optional. Used in conjunction with the `update` field. When `true`, `findAndModify()` (page 822) creates a new document if the `query` returns no documents. The default is `false`.

The `findAndModify()` (page 822) method returns either:

- the pre-modification document or,
- if the `new: true` option is set, the modified document.

Note:

- If no document is found for the `update` or `remove`, the the method returns `null`.
- If no document is found for an `upsert`, which means the command performs an insert, and `new` is `false`, **and** the `sort` option is **NOT** specified, the method returns `null`. Changed in version 2.2: Previously returned an empty document `{}`. See *the 2.2 release notes* (page 1040) for more information.
- If no document is found for an `upsert`, which means the command performs an insert, and `new` is `false`, **and** a `sort` option is specified, the method returns an empty document `{}`.

Consider the following examples:

- The following method updates an existing document in the people collection where the document matches the query criteria:

```
db.people.findAndModify( {
    query: { name: "Tom", state: "active", rating: { $gt: 10 } },
    sort: { rating: 1 },
    update: { $inc: { score: 1 } }
} )
```

This method performs the following actions:

1. The `query` finds a document in the `people` collection where the `name` field has the value `Tom`, the `state` field has the value `active` and the `rating` field has a value `greater than` (page 697) 10.
2. The `sort` orders the results of the query in ascending order. If multiple documents meet the `query` condition, the method will select for modification the first document as ordered by this `sort`.
3. The update `increments` (page 699) the value of the `score` field by 1.
4. The method returns the original (i.e. pre-modification) document selected for this update:

```
{
  "_id" : ObjectId("50f1e2c99beb36a0f45c6453"),
  "name" : "Tom",
  "state" : "active",
  "rating" : 100,
  "score" : 5
}
```

To return the modified document, add the `new:true` option to the method.

If no document matched the `query` condition, the method returns `null`:

```
null
```

- The following method includes the `upsert: true` option to insert a new document if no document matches the `query` condition:

```
db.people.findAndModify( {
    query: { name: "Gus", state: "active", rating: 100 },
    sort: { rating: 1 },
    update: { $inc: { score: 1 } },
    upsert: true
  } )
```

If the method does **not** find a matching document, the method performs an upsert. Because the method included the `sort` option, it returns an empty document `{ }` as the original (pre-modification) document:

```
{ }
```

If the method did **not** include a `sort` option, the method returns `null`.

```
null
```

- The following method includes both the `upsert: true` option and the `new:true` option to return the newly inserted document if a document matching the `query` is not found:

```
db.people.findAndModify( {
    query: { name: "Pascal", state: "active", rating: 25 },
    sort: { rating: 1 },
    update: { $inc: { score: 1 } },
    upsert: true,
    new: true
  }
)
```

The method returns the newly inserted document:

```
{
  "_id" : ObjectId("50f49ad6444c11ac2448a5d6"),
  "name" : "Pascal",
  "rating" : 25,
  "score" : 1,
  "state" : "active"
}
```

When `findAndModify()` (page 822) includes the `upsert: true` option **and** the query field(s) is not uniquely indexed, the method could insert a document multiple times in certain circumstances. For instance, if multiple clients each invoke the method with the same `query` condition and these methods complete the `find` phase before any of methods perform the `modify` phase, these methods could insert the same document.

Consider an example where no document with the name `Andy` exists and multiple clients issue the following command:

```
db.people.findAndModify(
                          {
                            query: { name: "Andy" },
                            sort: { rating: 1 },
```

```
        update: { $inc: { score: 1 } },
        upsert: true
      }
)
```

If all the methods finish the `query` phase before any command starts the `modify` phase, **and** there is no unique index on the `name` field, the commands may all perform an upsert. To prevent this condition, create a *unique index* (page 246) on the `name` field. With the unique index in place, the multiple methods would observe one of the following behaviors:

- Exactly one `findAndModify()` (page 822) would successfully insert a new document.
- Zero or more `findAndModify()` (page 822) methods would update the newly inserted document.
- Zero or more `findAndModify()` (page 822) methods would fail when they attempted to insert a duplicate. If the method fails due to a unique index constraint violation, you can retry the method. Absent a delete of the document, the retry should not fail.

Warning:

- When using `findAndModify` (page 758) in a *sharded* environment, the `query` must contain the *shard key* for all operations against the shard cluster. `findAndModify` (page 758) operations issued against `mongos` (page 905) instances for non-sharded collections function normally.

db.collection.findOne()

`db.collection.`**`findOne`**(*query*, *projection*)

Parameters

- **query** (*document*) – Optional. A *document* that specifies the *query* using the JSON-like syntax and *query operators* (page 882).
- **projection** (*document*) – Optional. Controls the fields to return, or the *projection*. The `projection` argument will resemble the following prototype:

  ```
  { field1: boolean, field2: boolean ... }
  ```

  The `boolean` can take the following include or exclude values:

  – `1` or `true` to include. The `findOne()` (page 825) method always includes the *_id* field even if the field is not explicitly stated to return in the *projection* parameter.

  – `0` or `false` to exclude.

  The `projection` cannot contain both include and exclude specifications except for the exclusion of the `_id` field.

  Omit the `projection` parameter to return **all** the fields in the matching documents.

Returns One document that satisfies the query specified as the argument to this method. If the `projection` argument is specified, the returned document contains only the `projection` fields, and the `_id` field if you do not explicitly exclude the `_id` field.

Returns only one document that satisfies the specified query. If multiple documents satisfy the query, this method returns the first document according to the *natural order* which reflects the order of documents on the disc. In *capped collections*, natural order is the same as insertion order.

db.collection.getIndexes()

db.collection.**getIndexes**()

Returns an array that holds a list of documents that identify and describe the existing indexes on the collection. You must call the db.collection.getIndexes() (page 826) on a collection. For example:

```
db.collection.getIndexes()
```

Change collection to the name of the collection whose indexes you want to learn.

The db.collection.getIndexes() (page 826) items consist of the following fields:

system.indexes.**v**

Holds the version of the index.

The index version depends on the version of mongod (page 897) that created the index. Before version 2.0 of MongoDB, the this value was 0; versions 2.0 and later use version 1.

system.indexes.**key**

Contains a document holding the keys held in the index, and the order of the index. Indexes may be either descending or ascending order. A value of negative one (e.g. -1) indicates an index sorted in descending order while a positive value (e.g. 1) indicates an index sorted in an ascending order.

system.indexes.**ns**

The namespace context for the index.

system.indexes.**name**

A unique name for the index comprised of the field names and orders of all keys.

db.collection.getShardDistribution()

db.collection.**getShardDistribution**()

Returns

Prints the data distribution statistics for a *sharded* collection. You must call the getShardDistribution() (page 826) method on a sharded collection, as in the following example:

```
db.myShardedCollection.getShardDistribution()
```

In the following example, the collection has two shards. The output displays both the individual shard distribution information as well the total shard distribution:

```
Shard <shard-a> at <host-a>
 data : <size-a> docs : <count-a> chunks : <number of chunks-a>
 estimated data per chunk : <size-a>/<number of chunks-a>
 estimated docs per chunk : <count-a>/<number of chunks-a>

Shard <shard-b> at <host-b>
 data : <size-b> docs : <count-b> chunks : <number of chunks-b>
 estimated data per chunk : <size-b>/<number of chunks-b>
 estimated docs per chunk : <count-b>/<number of chunks-b>

Totals
 data : <stats.size> docs : <stats.count> chunks : <calc total chunks>
 Shard <shard-a> contains  <estDataPercent-a>% data, <estDocPercent-a>% docs in cluster, avg obj
 Shard <shard-b> contains  <estDataPercent-b>% data, <estDocPercent-b>% docs in cluster, avg obj
```

The output information displays:

- `<shard-x>` is a string that holds the shard name.
- `<host-x>` is a string that holds the host name(s).
- `<size-x>` is a number that includes the size of the data, including the unit of measure (e.g. `b`, `Mb`).
- `<count-x>` is a number that reports the number of documents in the shard.
- `<number of chunks-x>` is a number that reports the number of chunks in the shard.
- `<size-x>/<number of chunks-x>` is a calculated value that reflects the estimated data size per chunk for the shard, including the unit of measure (e.g. `b`, `Mb`).
- `<count-x>/<number of chunks-x>` is a calculated value that reflects the estimated number of documents per chunk for the shard.
- `<stats.size>` is a value that reports the total size of the data in the sharded collection, including the unit of measure.
- `<stats.count>` is a value that reports the total number of documents in the sharded collection.
- `<calc total chunks>` is a calculated number that reports the number of chunks from all shards, for example:

  ```
  <calc total chunks> = <number of chunks-a> + <number of chunks-b>
  ```

- `<estDataPercent-x>` is a calculated value that reflects, for each shard, the data size as the percentage of the collection's total data size, for example:

  ```
  <estDataPercent-x> = <size-x>/<stats.size>
  ```

- `<estDocPercent-x>` is a calculated value that reflects, for each shard, the number of documents as the percentage of the total number of documents for the collection, for example:

  ```
  <estDocPercent-x> = <count-x>/<stats.count>
  ```

- `stats.shards[ <shard-x> ].avgObjSize` is a number that reflects the average object size, including the unit of measure, for the shard.

For example, the following is a sample output for the distribution of a sharded collection:

```
Shard shard-a at shard-a/MyMachine.local:30000,MyMachine.local:30001,MyMachine.local:30002
data : 38.14Mb docs : 1000003 chunks : 2
estimated data per chunk : 19.07Mb
estimated docs per chunk : 500001

Shard shard-b at shard-b/MyMachine.local:30100,MyMachine.local:30101,MyMachine.local:30102
data : 38.14Mb docs : 999999 chunks : 3
estimated data per chunk : 12.71Mb
estimated docs per chunk : 333333

Totals
data : 76.29Mb docs : 2000002 chunks : 5
Shard shard-a contains 50% data, 50% docs in cluster, avg obj size on shard : 40b
Shard shard-b contains 49.99% data, 49.99% docs in cluster, avg obj size on shard : 40b
```

See Also:

Sharding (page 363)

db.collection.getShardVersion()

db.collection.**getShardVersion**()

This method returns information regarding the state of data in a *sharded cluster* that is useful when diagnosing underlying issues with a sharded cluster.

For internal and diagnostic use only.

db.collection.group()

db.collection.**group**(*{ key, reduce, initial, [keyf,] [cond,] finalize }*)

The db.collection.group() (page 828) method groups documents in a collection by the specified keys and performs simple aggregation functions such as computing counts and sums. The method is analogous to a SELECT .. GROUP BY statement in SQL. The group() (page 828) method returns an array.

The db.collection.group() (page 828) accepts a single *document* that contains the following:

Fields

- **key** – Specifies one or more document fields to group by.
- **reduce** – Specifies a function for the group operation perform on the documents during the grouping operation, such as compute a sum or a count. The aggregation function takes two arguments: the current document and the aggregate result for the previous documents in the.
- **initial** – Initializes the aggregation result document.
- **keyf** – Optional. Alternative to the key field. Specifies a function that creates a "key object" for use as the grouping key. Use the keyf instead of key to group by calculated fields rather than existing document fields.
- **cond** – Optional. Specifies the selection criteria to determine which documents in the collection to process. If you omit the cond field, db.collection.group() (page 828) processes all the documents in the collection for the group operation.
- **finalize** – Optional. Specifies a function that runs each item in the result set before db.collection.group() (page 828) returns the final value. This function can either modify the result document or replace the result document as a whole.

The db.collection.group() (page 828) method is a shell wrapper for the group (page 769) command; however, the db.collection.group() (page 828) method takes the keyf field and the reduce field whereas the group (page 769) command takes the $keyf field and the $reduce field.

Warning:

- The db.collection.group() (page 828) method does not work with *sharded clusters*. Use the *aggregation framework* or *map-reduce* in *sharded environments*.
- The group (page 769) command takes a read lock and does not allow any other threads to execute JavaScript while it is running.

Note:

- The result set must fit within the *maximum BSON document size* (page 1021).
- In version 2.2, the returned array can contain at most 20,000 elements; i.e. at most 20,000 unique groupings. For group by operations that results in more than 20,000 unique groupings, use mapReduce (page 775). Previous versions had a limit of 10,000 elements.

Consider the following examples of the db.collection.group() (page 828) method:

The examples assume an orders collection with documents of the following prototype:

```
{
  _id: ObjectId("5085a95c8fada716c89d0021"),
  ord_dt: ISODate("2012-07-01T04:00:00Z"),
  ship_dt: ISODate("2012-07-02T04:00:00Z"),
  item: { sku: "abc123",
          price: 1.99,
          uom: "pcs",
          qty: 25 }
}
```

- The following example groups by the ord_dt and item.sku fields those documents that have ord_dt greater than 01/01/2011:

  ```
  db.orders.group( {
                      key: { ord_dt: 1, 'item.sku': 1 },
                      cond: { ord_dt: { $gt: new Date( '01/01/2012' ) } },
                      reduce: function ( curr, result ) { },
                      initial: { }
                    } )
  ```

  The result is an array of documents that contain the group by fields:

  ```
  [ { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc123"},
    { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc456"},
    { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "bcd123"},
    { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "efg456"},
    { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "abc123"},
    { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "efg456"},
    { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "ijk123"},
    { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc123"},
    { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc456"},
    { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc123"},
    { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc456"} ]
  ```

  The method call is analogous to the SQL statement:

  ```
  SELECT ord_dt, item_sku
  FROM orders
  WHERE ord_dt > '01/01/2012'
  GROUP BY ord_dt, item_sku
  ```

- The following example groups by the ord_dt and item.sku fields, those documents that have ord_dt greater than 01/01/2011 and calculates the sum of the qty field for each grouping:

  ```
  db.orders.group( {
                      key: { ord_dt: 1, 'item.sku': 1 },
                      cond: { ord_dt: { $gt: new Date( '01/01/2012' ) } },
                      reduce: function ( curr, result ) {
                                  result.total += curr.item.qty;
                              },
                      initial: { total : 0 }
                    } )
  ```

  The result is an array of documents that contain the group by fields and the calculated aggregation field:

```
[ { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc123", "total" : 25 },
  { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "abc456", "total" : 25 },
  { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "bcd123", "total" : 10 },
  { "ord_dt" : ISODate("2012-07-01T04:00:00Z"), "item.sku" : "efg456", "total" : 10 },
  { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "abc123", "total" : 25 },
  { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "efg456", "total" : 15 },
  { "ord_dt" : ISODate("2012-06-01T04:00:00Z"), "item.sku" : "ijk123", "total" : 20 },
  { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc123", "total" : 45 },
  { "ord_dt" : ISODate("2012-05-01T04:00:00Z"), "item.sku" : "abc456", "total" : 25 },
  { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc123", "total" : 25 },
  { "ord_dt" : ISODate("2012-06-08T04:00:00Z"), "item.sku" : "abc456", "total" : 25 } ]
```

The method call is analogous to the SQL statement:

```
SELECT ord_dt, item_sku, SUM(item_qty) as total
FROM orders
WHERE ord_dt > '01/01/2012'
GROUP BY ord_dt, item_sku
```

- The following example groups by the calculated `day_of_week` field, those documents that have `ord_dt` greater than `01/01/2011` and calculates the sum, count, and average of the `qty` field for each grouping:

```
db.orders.group( {
                    keyf: function(doc) {
                              return { day_of_week: doc.ord_dt.getDay() } ; },
                    cond: { ord_dt: { $gt: new Date( '01/01/2012' ) } },
                    reduce: function ( curr, result ) {
                                result.total += curr.item.qty;
                                result.count++;
                            },
                    initial: { total : 0, count: 0 },
                    finalize: function(result) {
                                var weekdays = [ "Sunday", "Monday", "Tuesday",
                                                 "Wednesday", "Thursday",
                                                 "Friday", "Saturday" ];

                                result.day_of_week = weekdays[result.day_of_week];
                                result.avg = Math.round(result.total / result.count);

                    }
                } )
```

The result is an array of documents that contain the group by fields and the calculated aggregation field:

```
[ { "day_of_week" : "Sunday", "total" : 70, "count" : 4, "avg" : 18 },
  { "day_of_week" : "Friday", "total" : 110, "count" : 6, "avg" : 18 },
  { "day_of_week" : "Tuesday", "total" : 70, "count" : 3, "avg" : 23 } ]
```

See Also:

Aggregation Framework (page 195)

db.collection.insert()

`db.collection.insert(document)`

The `insert()` (page 830) method inserts a document or documents into a collection. Changed in version 2.2: The `insert()` (page 830) method can accept an array of documents to perform a bulk insert of the documents into the collection.

Note: For bulk inserts on sharded clusters, the `getLastError` (page 766) command alone is insufficient to verify success. Applications should must verify the success of bulk inserts in application logic.

Consider the following behaviors of the `insert()` (page 830) method:

- If the collection does not exist, then the `insert()` (page 830) method will create the collection.
- If the document does not specify an *_id* field, then MongoDB will add the `_id` field and assign a unique *ObjectId* for the document before inserting. Most drivers create an ObjectId and insert the `_id` field, but the `mongod` (page 897) will create and populate the `_id` if the driver or application does not.
- If the document specifies a new field, then the `insert()` (page 830) method inserts the document with the new field. This requires no changes to the data model for the collection or the existing documents.

The `insert()` (page 830) method takes one of the following parameters:

Parameters

- **document** – A document to insert into the collection.
- **documents** (*array*) – New in version 2.2. An array of documents to insert into the collection.

Consider the following examples of the `insert()` (page 830) method:

- To insert a single document and have MongoDB generate the unique `_id`, omit the `_id` field in the document and pass the document to the `insert()` (page 830) method as in the following:

```
db.products.insert( { item: "card", qty: 15 } )
```

This operation inserts a new document into the `products` collection with the `item` field set to `card`, the `qty` field set to `15`, and the `_id` field set to a unique `ObjectId`:

```
{ "_id" : ObjectId("5063114bd386d8fadbd6b004"), "item" : "card", "qty" : 15 }
```

Note: Most MongoDB driver clients will include the `_id` field and generate an `ObjectId` before sending the insert operation to MongoDB; however, if the client sends a document without an `_id` field, the `mongod` (page 897) will add the `_id` field and generate the `ObjectId`.

- To insert a single document, with a custom `_id` field, include the `_id` field set to a unique identifier and pass the document to the `insert()` (page 830) method as follows:

```
db.products.insert( { _id: 10, item: "box", qty: 20 } )
```

This operation inserts a new document in the `products` collection with the `_id` field set to `10`, the `item` field set to `box`, the `qty` field set to `20`:

```
{ "_id" : 10, "item" : "box", "qty" : 20 }
```

Note: Most MongoDB driver clients will include the `_id` field and generate an `ObjectId` before sending the insert operation to MongoDB; however, if the client sends a document without an `_id` field, the `mongod` (page 897) will add the `_id` field and generate the `ObjectId`.

- To insert multiple documents, pass an array of documents to the `insert()` (page 830) method as in the following:

```
db.products.insert( [ { _id: 11, item: "pencil", qty: 50, type: "no.2" },
                      {          item: "pen", qty: 20 },
                      {          item: "eraser", qty: 25 } ] )
```

The operation will insert three documents into the `products` collection:

- A document with the fields `_id` set to `11`, `item` set to `pencil`, `qty` set to `50`, and the `type` set to `no.2`.
- A document with the fields `_id` set to a unique `objectid`, `item` set to `pen`, and `qty` set to `20`.
- A document with the fields `_id` set to a unique `objectid`, `item` set to `eraser`, and `qty` set to `25`.

```
{ "_id" : 11, "item" : "pencil", "qty" : 50, "type" : "no.2" }
{ "_id" : ObjectId("50631bc0be4617f17bb159ca"), "item" : "pen", "qty" : 20 }
{ "_id" : ObjectId("50631bc0be4617f17bb159cb"), "item" : "eraser", "qty" : 25 }
```

db.collection.isCapped()

`db.collection.`**`isCapped`**`()`

Returns Returns `true` if the collection is a *capped collection*, otherwise returns `false`.

See Also:

Capped Collections (page 440)

db.collection.mapReduce()

`db.collection.`**`mapReduce`**(*map*, *reduce*, *{<out>*, *<query>*, *<sort>*, *<limit>*, *<finalize>*, *<scope>*, *<jsMode>*, *<verbose>}*)

The `db.collection.mapReduce()` (page 832) method provides a wrapper around the `mapReduce` (page 775) command.

```
db.collection.mapReduce(
                         <map>,
                         <reduce>,
                         {
                           out: <collection>,
                           query: <document>,
                           sort: <document>,
                           limit: <number>,
                           finalize: <function>,
                           scope: <document>,
                           jsMode: <boolean>,
                           verbose: <boolean>
                         }
                       )
```

`db.collection.mapReduce()` (page 832) takes the following parameters:

Parameters

- **map** – A JavaScript function that associates or "maps" a `value` with a `key` and emits the `key` and value `pair`.

The map function processes every input document for the map-reduce operation. The map-reduce operation groups the emitted value objects by the key and passes these groupings to the reduce function.

- **reduce** – A JavaScript function that "reduces" to a single object all the values associated with a particular key.

  The reduce function accepts two arguments: key and values. The values argument is an array whose elements are the value objects that are "mapped" to the key.

- **out** – New in version 1.8. Specifies the location of the result of the map-reduce operation. You can output to a collection, output to a collection with an action, or output inline. You may output to a collection when performing map reduce operations on the primary members of the set; on *secondary* members you may only use the inline output.

- **query** – Optional. Specifies the selection criteria using *query operators* (page 882) for determining the documents input to the map function.

- **sort** – Optional. Sorts the *input* documents. This option is useful for optimization. For example, specify the sort key to be the same as the emit key so that there are fewer reduce operations.

- **limit** – Optional. Specifies a maximum number of documents to return from the collection.

- **finalize** – Optional. A JavaScript function that follows the reduce method and modifies the output.

  The finalize function receives two arguments: key and reducedValue. The reducedValue is the value returned from the reduce function for the key.

- **scope** (*document*) – Optional. Specifies global variables that are accessible in the map , reduce and the finalize functions.

- **jsMode** (*Boolean*) – New in version 2.0. Optional. Specifies whether to convert intermediate data into BSON format between the execution of the map and reduce functions.

  If false:

  – Internally, MongoDB converts the JavaScript objects emitted by the map function to BSON objects. These BSON objects are then converted back to JavaScript objects when calling the reduce function.

  – The map-reduce operation places the intermediate BSON objects in temporary, on-disk storage. This allows the map-reduce operation to execute over arbitrarily large data sets.

  If true:

  – Internally, the JavaScript objects emitted during map function remain as JavaScript objects. There is no need to convert the objects for the reduce function, which can result in faster execution.

  – You can only use jsMode for result sets with fewer than 500,000 distinct key arguments to the mapper's emit() function.

  The jsMode defaults to false.

- **verbose** (*Boolean*) – Optional. Specifies whether to include the timing information in the result information. The verbose defaults to true to include the timing information.

Requirements for the map Function

The map function has the following prototype:

```
function() {
   ...
   emit(key, value);
}
```

The `map` function exhibits the following behaviors:

- In the `map` function, reference the current document as `this` within the function.
- The `map` function should *not* access the database for any reason.
- The `map` function should be pure, or have *no* impact outside of the function (i.e. side effects.)
- The `emit(key,value)` function associates the `key` with a `value`.
  - A single emit can only hold half of MongoDB's *maximum BSON document size* (page 1021).
  - There is no limit to the number of times you may call the `emit` function per document.
- The `map` function can access the variables defined in the `scope` parameter.

Requirements for the `reduce` Function

The `reduce` function has the following prototype:

```
function(key, values) {
   ...
   return result;
}
```

The `reduce` function exhibits the following behaviors:

- The `reduce` function should *not* access the database, even to perform read operations.
- The `reduce` function should *not* affect the outside system.
- MongoDB will **not** call the `reduce` function for a key that has only a single value.
- The `reduce` function can access the variables defined in the `scope` parameter.

Because it is possible to invoke the `reduce` function more than once for the same key, the following properties need to be true:

- the *type* of the return object must be **identical** to the type of the `value` emitted by the `map` function to ensure that the following operations is true:

  ```
  reduce(key, [ C, reduce(key, [ A, B ]) ] ) == reduce( key, [ C, A, B ] )
  ```

- the `reduce` function must be *idempotent*. Ensure that the following statement is true:

  ```
  reduce( key, [ reduce(key, valuesArray) ] ) == reduce( key, valuesArray )
  ```

- the order of the elements in the `valuesArray` should not affect the output of the `reduce` function, so that the following statement is true:

  ```
  reduce( key, [ A, B ] ) == reduce( key, [ B, A ] )
  ```

`out` Options

You can specify the following options for the `out` parameter:

Output to a Collection

```
out: <collectionName>
```

Output to a Collection with an Action This option is only available when passing `out` a collection that already exists. This option is not available on secondary members of replica sets.

```
out: { <action>: <collectionName>
          [, db: <dbName>]
          [, sharded: <boolean> ]
          [, nonAtomic: <boolean> ] }
```

When you output to a collection with an action, the `out` has the following parameters:

- `<action>`: Specify one of the following actions:
  - `replace`

    Replace the contents of the `<collectionName>` if the collection with the `<collectionName>` exists.
  - `merge`

    Merge the new result with the existing result if the output collection already exists. If an existing document has the same key as the new result, *overwrite* that existing document.
  - `reduce`

    Merge the new result with the existing result if the output collection already exists. If an existing document has the same key as the new result, apply the `reduce` function to both the new and the existing documents and overwrite the existing document with the result.
- `db`:

  Optional.The name of the database that you want the map-reduce operation to write its output. By default this will be the same database as the input collection.
- `sharded`:

  Optional. If `true` *and* you have enabled sharding on output database, the map-reduce operation will shard the output collection using the `_id` field as the shard key.
- `nonAtomic`: New in version 2.2. Optional. Specify output operation as non-atomic and is valid *only* for `merge` and `reduce` output modes which may take minutes to execute.

  If `nonAtomic` is `true`, the post-processing step will prevent MongoDB from locking the database; however, other clients will be able to read intermediate states of the output collection. Otherwise the map reduce operation must lock the database during post-processing.

Output Inline Perform the map-reduce operation in memory and return the result. This option is the only available option for `out` on secondary members of replica sets.

```
out: { inline: 1 }
```

The result must fit within the *maximum size of a BSON document* (page 1021).

Requirements for the `finalize` Function

The `finalize` function has the following prototype:

```
function(key, reducedValue) {
   ...
   return modifiedObject;
}
```

The `finalize` function receives as its arguments a `key` value and the `reducedValue` from the `reduce` function. Be aware that:

- The `finalize` function should *not* access the database for any reason.
- The `finalize` function should be pure, or have *no* impact outside of the function (i.e. side effects.)
- The `finalize` function can access the variables defined in the `scope` parameter.

Map-Reduce Examples

Consider the following map-reduce operations on a collection `orders` that contains documents of the following prototype:

```
{
     _id: ObjectId("50a8240b927d5d8b5891743c"),
     cust_id: "abc123",
     ord_date: new Date("Oct 04, 2012"),
     status: 'A',
     price: 250,
     items: [ { sku: "mmm", qty: 5, price: 2.5 },
              { sku: "nnn", qty: 5, price: 2.5 } ]
}
```

Return the Total Price Per Customer Id Perform map-reduce operation on the `orders` collection to group by the `cust_id`, and for each `cust_id`, calculate the sum of the `price` for each `cust_id`:

1. Define the map function to process each input document:
   - In the function, `this` refers to the document that the map-reduce operation is processing.
   - The function maps the `price` to the `cust_id` for each document and emits the `cust_id` and `price` pair.

   ```
   var mapFunction1 = function() {
                          emit(this.cust_id, this.price);
                      };
   ```

2. Define the corresponding reduce function with two arguments `keyCustId` and `valuesPrices`:
   - The `valuesPrices` is an array whose elements are the `price` values emitted by the map function and grouped by `keyCustId`.
   - The function reduces the `valuesPrice` array to the sum of its elements.

   ```
   var reduceFunction1 = function(keyCustId, valuesPrices) {
                             return Array.sum(valuesPrices);
                         };
   ```

3. Perform the map-reduce on all documents in the `orders` collection using the `mapFunction1` map function and the `reduceFunction1` reduce function.

```
db.orders.mapReduce(
                     mapFunction1,
                     reduceFunction1,
                     { out: "map_reduce_example" }
                   )
```

This operation outputs the results to a collection named `map_reduce_example`. If the `map_reduce_example` collection already exists, the operation will replace the contents with the results of this map-reduce operation:

Calculate the Number of Orders, Total Quantity, and Average Quantity Per Item In this example you will perform a map-reduce operation on the `orders` collection, for all documents that have an `ord_date` value greater than `01/01/2012`. The operation groups by the `item.sku` field, and for each `sku` calculates the number of orders and the total quantity ordered. The operation concludes by calculating the average quantity per order for each `sku` value:

1. Define the map function to process each input document:
   - In the function, `this` refers to the document that the map-reduce operation is processing.
   - For each item, the function associates the `sku` with a new object `value` that contains the `count` of `1` and the item `qty` for the order and emits the `sku` and `value` pair.

```
var mapFunction2 = function() {
                       for (var idx = 0; idx < this.items.length; idx++) {
                           var key = this.items[idx].sku;
                           var value = {
                                         count: 1,
                                         qty: this.items[idx].qty
                                       };
                           emit(key, value);
                       }
                   };
```

2. Define the corresponding reduce function with two arguments `keySKU` and `valuesCountObjects`:
   - `valuesCountObjects` is an array whose elements are the objects mapped to the grouped `keySKU` values passed by map function to the reducer function.
   - The function reduces the `valuesCountObjects` array to a single object `reducedValue` that also contains the `count` and the `qty` fields.
   - In `reducedValue`, the `count` field contains the sum of the `count` fields from the individual array elements, and the `qty` field contains the sum of the `qty` fields from the individual array elements.

```
var reduceFunction2 = function(keySKU, valuesCountObjects) {
                          reducedValue = { count: 0, qty: 0 };

                          for (var idx = 0; idx < valuesCountObjects.length; idx++) {
                              reducedValue.count += valuesCountObjects[idx].count;
                              reducedValue.qty += valuesCountObjects[idx].qty;
                          }

                          return reducedValue;
                      };
```

3. Define a finalize function with two arguments `key` and `reducedValue`. The function modifies the `reducedValue` object to add a computed field named `average` and returns the modified object:

```
var finalizeFunction2 = function (key, reducedValue) {

                            reducedValue.average = reducedValue.qty/reducedValue.count;

                            return reducedValue;
                        };
```

4. Perform the map-reduce operation on the `orders` collection using the `mapFunction2`, `reduceFunction2`, and `finalizeFunction2` functions.

   ```
   db.orders.mapReduce( mapFunction2,
                        reduceFunction2,
                        {
                          out: { merge: "map_reduce_example" },
                          query: { ord_date: { $gt: new Date('01/01/2012') } },
                          finalize: finalizeFunction2
                        }
                      )
   ```

   This operation uses the `query` field to select only those documents with `ord_date` greater than `new Date(01/01/2012)`. Then it output the results to a collection `map_reduce_example`. If the `map_reduce_example` collection already exists, the operation will merge the existing contents with the results of this map-reduce operation:

For more information and examples, see the *Map-Reduce* (page 223) page.

See Also:

- *map-reduce* and `mapReduce` (page 775) command
- *Aggregation Framework* (page 195)

db.collection.reIndex()

`db.collection.reIndex()`

This method drops all indexes and recreates them. This operation may be expensive for collections that have a large amount of data and/or a large number of indexes.

Call this method, which takes no arguments, on a collection object. For example:

```
db.collection.reIndex()
```

Change `collection` to the name of the collection that you want to rebuild the index.

db.collection.remove()

`db.collection.remove(`*query*, *justOne*`)`

The `remove` (page 838) method removes documents from a collection.

The `remove()` (page 838) method can take the following parameters:

Parameters

- **query** (*document*) – Optional. Specifies the deletion criteria using *query operators* (page 882). Omit the `query` parameter or pass an empty document (e.g. `{}`) to delete all *documents* in the *collection*.
- **justOne** (*boolean*) – Optional. A boolean that limits the deletion to just one document. The default value is `false`. Set to `true` to delete only the first result.

Note: You cannot use the remove() (page 838) method with a *capped collection*.

Consider the following examples of the remove (page 838) method.

- To remove all documents in a collection, call the remove (page 838) method with no parameters:

  ```
  db.products.remove()
  ```

  This operation will remove all the documents from the collection products.

- To remove the documents that match a deletion criteria, call the remove (page 838) method with the query criteria:

  ```
  db.products.remove( { qty: { $gt: 20 } } )
  ```

  This operation removes all the documents from the collection products where qty is greater than 20.

- To remove the first document that match a deletion criteria, call the remove (page 838) method with the query criteria and the justOne parameter set to true or 1:

  ```
  db.products.remove( { qty: { $gt: 20 } }, true )
  ```

  This operation removes all the documents from the collection products where qty is greater than 20.

Note: If the query argument to the remove() (page 838) method matches multiple documents in the collection, the delete operation may interleave with other write operations to that collection. For an unsharded collection, you have the option to override this behavior with the $isolated (page 699) isolation operator, effectively isolating the delete operation and blocking other write operations during the delete. To isolate the query, include $isolated: 1 in the query parameter as in the following example:

```
db.products.remove( { qty: { $gt: 20 }, $isolated: 1 } )
```

db.collection.renameCollection()

db.collection.**renameCollection**()

db.collection.renameCollection() (page 839) provides a helper for the renameCollection (page 786) *database command* in the mongo (page 908) shell to rename existing collections.

Parameters

- **target** (*string*) – Specifies the new name of the collection. Enclose the string in quotes.
- **dropTarget** (*boolean*) – Optional. If true, mongod (page 897) will drop the *target* of renameCollection (page 786) prior to renaming the collection.

Call the db.collection.renameCollection() (page 839) method on a collection object, to rename a collection. Specify the new name of the collection as an argument. For example:

```
db.rrecord.renameCollection("record")
```

This operation will rename the rrecord collection to record. If the target name (i.e. record) is the name of an existing collection, then the operation will fail.

Consider the following limitations:

- db.collection.renameCollection() (page 839) cannot move a collection between databases. Use renameCollection (page 786) for these rename operations.

- db.collection.renameCollection() (page 839) cannot operation on sharded collections.

The db.collection.renameCollection() (page 839) method operates within a collection by changing the metadata associated with a given collection.

Refer to the documentation renameCollection (page 786) for additional warnings and messages.

Warning: The db.collection.renameCollection() (page 839) method and renameCollection (page 786) command will invalidate open cursors which interrupts queries that are currently returning data.

db.collection.save()

db.collection.**save**(*document*)

The save() (page 840) method updates an existing document or inserts a document depending on the parameter.

The save() (page 840) method takes the following parameter:

Parameters

- **document** – Specify a document to save to the collection.

  If the document does not contain an *_id* field, then the save() (page 840) method performs an insert with the specified fields in the document as well as an _id field with a unique *objectid* value.

  If the document contains an _id field, then the save() (page 840) method performs an upsert querying the collection on the _id field:

  – If a document does not exist with the specified _id value, the save() (page 840) method performs an insert with the specified fields in the document.

  – If a document exists with the specified _id value, the save() (page 840) method performs an update, replacing all field in the existing record with the fields from the document.

Consider the following examples of the save() (page 840) method:

- Pass to the save() (page 840) method a document without an _id field, so that to insert the document into the collection and have MongoDB generate the unique _id as in the following:

```
db.products.save( { item: "book", qty: 40 } )
```

This operation inserts a new document into the products collection with the item field set to book, the qty field set to 40, and the _id field set to a unique ObjectId:

```
{ "_id" : ObjectId("50691737d386d8fadbd6b01d"), "item" : "book", "qty" : 40 }
```

Note: Most MongoDB driver clients will include the _id field and generate an ObjectId before sending the insert operation to MongoDB; however, if the client sends a document without an _id field, the mongod (page 897) will add the _id field and generate the ObjectId.

- Pass to the save() (page 840) method a document with an _id field that holds a value that does not exist in the collection to insert the document with that value in the _id value into the collection, as in the following:

```
db.products.save( { _id: 100, item: "water", qty: 30 } )
```

This operation inserts a new document into the `products` collection with the `_id` field set to `100`, the `item` field set to `water`, and the field `qty` set to `30`:

```
{ "_id" : 100, "item" : "water", "qty" : 30 }
```

Note: Most MongoDB driver clients will include the `_id` field and generate an `ObjectId` before sending the insert operation to MongoDB; however, if the client sends a document without an `_id` field, the `mongod` (page 897) will add the `_id` field and generate the `ObjectId`.

- Pass to the `save()` (page 840) method a document with the `_id` field set to a value in the `collection` to replace all fields and values of the matching document with the new fields and values, as in the following:

```
db.products.save( { _id:100, item:"juice" } )
```

This operation replaces the existing document with a value of `100` in the `_id` field. The updated document will resemble the following:

```
{ "_id" : 100, "item" : "juice" }
```

db.collection.stats()

`db.collection.`**`stats`**`(`*scale*`)`

Parameters

- **scale** – Optional. Specifies the scale to deliver results. Unless specified, this command returns all sizes in bytes.

Returns A *document* containing statistics that reflecting the state of the specified collection.

This function provides a wrapper around the database command `collStats` (page 745). The `scale` option allows you to configure how the `mongo` (page 908) shell scales the sizes of things in the output. For example, specify a `scale` value of `1024` to display kilobytes rather than bytes.

Call the `db.collection.stats()` (page 841) method on a collection object, to return statistics regarding that collection. For example, the following operation returns stats on the `people` collection:

```
db.people.stats()
```

See Also:

"*Collection Statistics Reference* (page 980)" for an overview of the output of this command.

db.collection.storageSize()

`db.collection.`**`storageSize`**`()`

Returns The total amount of storage allocated to this collection for document storage. Provides a wrapper around the `storageSize` (page 981) field of the `collStats` (page 745) (i.e. `db.collection.stats()` (page 841)) output.

db.collection.totalIndexSize()

db.collection.**totalIndexSize**()

Returns The total size of all indexes for the collection. This method provides a wrapper around the totalIndexSize (page 982) output of the collStats (page 745) (i.e. db.collection.stats() (page 841)) operation.

db.collection.totalSize()

db.collection.**totalSize**()

Returns The total size of the data in the collection plus the size of every indexes on the collection.

db.collection.update()

db.collection.**update**(*query*, *update*[, *options*])

The update() (page 842) method modifies an existing document or documents in a collection. By default the update() (page 842) method updates a single document. To update all documents in the collection that match the update query criteria, specify the multi option. To insert a document if no document matches the update query criteria, specify the upsert option. Changed in version 2.2: The mongo (page 908) shell provides an updated interface that accepts the options parameter in a document format to specify multi and upsert options. Prior to version 2.2, in the mongo (page 908) shell, upsert and multi were positional boolean options:

```
db.collection.update(query, update, <upsert>, <multi>)
```

The update() (page 842) method takes the following parameters:

Parameters

- **query** (*document*) – Specifies the selection criteria for the update. The query parameter employs the same *query selectors* (page 882) as used in the db.collection.find() (page 820) method.
- **update** (*document*) – Specifies the modifications to apply.

  If the update parameter contains any *update operators* (page 884) expressions such as the $set (page 716) operator expression, then:

  – the update parameter must contain only update operators expressions.

  – the update() (page 842) method updates only the corresponding fields in the document.

  If the update parameter consists only of field: value expressions, then:

  – the update() (page 842) method *replaces* the document with the updates document. If the updates document is missing the *_id* field, MongoDB will add the _id field and assign to it a unique *objectid* .

  – the update() (page 842) method updates cannot update multiple documents.
- **options** (*document*) – New in version 2.2. Optional. Specifies whether to perform an *upsert* and/or a multiple update. Use the options parameter instead of the individual upsert and multi parameters.
- **upsert** (*boolean*) – Optional. Specifies an *upsert* operation

  The default value is false. When true, the update() (page 842) method will update an existing document that matches the query selection criteria **or** if no document matches

the criteria, insert a new document with the fields and values of the `update` parameter and if the `update` included only `update operators`, the `query` parameter as well .

In version 2.2 of the `mongo` (page 908) shell, you may also specify `upsert` in the `options` parameter.

Note: With `upsert` `update()` (page 842) inserts a *single* document.

- **multi** (*boolean*) – Optional. Specifies whether to update multiple documents that meet the query criteria.

  When not specified, the default value is `false` and the `update()` (page 842) method updates a single document that meet the `query` criteria.

  When `true`, the `update()` (page 842) method updates all documents that meet the `query` criteria.

  In version 2.2 of the `mongo` (page 908) shell, you may also specify `multi` in the `options` parameter.

  Note: The `multi` update operation may interleave with other write operations. For unsharded collections, you can override this behavior with the `$isolated` (page 699) isolation operator, which isolates the update operation and blocks other write operations during the update. See the *isolation operator* (page 699).

Although the update operation may apply mostly to updating the values of the fields, the `update()` (page 842) method can also modify the name of the `field` in a document using the `$rename` (page 714) operator.

Consider the following examples of the `update()` (page 842) method. These examples all use the 2.2 interface to specify options in the document form.

- To update specific fields in a document, call the `update()` (page 842) method with an `update` parameter using `field: value` pairs and expressions using *update operators* (page 884) as in the following:

```
db.products.update( { item: "book", qty: { $gt: 5 } }, { $set: { x: 6 }, $inc: { y: 5} } )
```

  This operation updates a document in the `products` collection that matches the query criteria and sets the value of the field `x` to `6`, and increment the value of the field `y` by `5`. All other fields of the document remain the same.

- To replace all the fields in a document with the document as specified in the `update` parameter, call the `update()` (page 842) method with an `update` parameter that consists of *only* `key: value` expressions, as in the following:

```
db.products.update( { item: "book", qty: { $gt: 5 } }, { x: 6, y: 15 } )
```

  This operation selects a document from the `products` collection that matches the query criteria sets the value of the field `x` to `6` and the value of the field `y` to `15`. All other fields of the matched document are *removed*, except the *_id* field.

- To update multiple documents, call the `update()` (page 842) method and specify the `multi` option in the `options` argument, as in the following:

```
db.products.update( { item: "book", qty: { $gt: 5 } }, { $set: { x: 6, y: 15 } }, { multi: t
```

  This operation updates *all* documents in the `products` collection that match the query criteria by setting the value of the field `x` to `6` and the value of the field `y` to `15`. This operation does not affect any other fields in documents in the `products` collection.

You can perform the same operation by calling the `update()` (page 842) method with the `multi` parameter:

```
db.products.update( { item: "book", qty: { $gt: 5 } }, { $set: { x: 6, y: 15 } }, false, tru
```

- To update a document or to insert a new document if no document matches the query criteria, call the `update()` (page 842) and specify the `upsert` option in the `options` argument, as in the following:

```
db.products.update( { item: "magazine", qty: { $gt: 5 } }, { $set: { x: 25, y: 50 } }, { ups
```

This operation will:

  - update a single document in the `products` collection that matches the query criteria, setting the value of the field `x` to `25` and the value of the field `y` to `50`, *or*
  - if no matching document exists, insert a document in the `products` collection, with the field `item` set to `magazine`, the field `x` set to `25`, and the field `y` set to `50`.

db.collection.validate()

`db.collection.validate()`

Parameters

- **full** (*Boolean*) – Optional. Specify `true` to enable a full validation. MongoDB disables full validation by default because it is a potentially resource intensive operation.

Provides a wrapper around the `validate` (page 799) *database command*. Call the `db.collection.validate()` (page 844) method on a collection object, to validate the collection itself. Specify the full option to return full statistics.

The `validation` (page 799) operation scans all of the data structures for correctness and returns a single *document* that describes the relationship between the logical collection and the physical representation of that data.

The output can provide a more in depth view of how the collection uses storage. Be aware that this command is potentially resource intensive, and may impact the performance of your MongoDB instance.

See Also:

Collection Validation Data (page 982)

db.commandHelp()

`db.commandHelp(command)`

Parameters

- **command** – Specifies a *database command name* (page 885).

Returns Help text for the specified *database command*. See the *database command reference* (page 885) for full documentation of these commands.

db.copyDatabase()

`db.copyDatabase(origin, destination, hostname)`

Parameters

- **origin** (*database*) – Specifies the name of the database on the origin system.

- **destination** (*database*) – Specifies the name of the database that you wish to copy the origin database into.
- **hostname** (*origin*) – Indicate the hostname of the origin database host. Omit the hostname to copy from one name to another on the same server.

Use this function to copy a specific database, named `origin` running on the system accessible via `hostname` into the local database named `destination`. The command creates destination databases implicitly when they do not exist. If you omit the hostname, MongoDB will copy data from one database into another on the same instance.

This function provides a wrapper around the MongoDB *database command* "`copydb` (page 749)." The `clone` (page 743) database command provides related functionality.

db.createCollection()

`db.createCollection` (*name*[, *{capped: <boolean>, size: <value>, max <bytes>}*])

Parameters

- **name** (*string*) – Specifies the name of a collection to create.
- **capped** (*boolean*) – Optional. If this *document* is present, this command creates a capped collection. The capped argument is a *document* that contains the following three fields:
- **capped** – Enables a *collection cap*. False by default. If enabled, you must specify a `size` parameter.
- **size** (*bytes*) – If `capped` is `true`, `size` specifies a maximum size in bytes for the capped collection. When `capped` is false, you may use `size` to preallocate space.
- **max** (*int*) – Optional. Specifies a maximum "cap," in number of documents for capped collections. You must also specify `size` when specifying `max`.

Options

- **autoIndexId** – If `capped` is `true` you can specify `false` to disable the automatic index created on the `_id` field. Before 2.2, the default value for `autoIndexId` was `false`. See *_id Fields and Indexes on Capped Collections* (page 1042) for more information.

Explicitly creates a new collection. Because MongoDB creates collections implicitly when referenced, this command is primarily used for creating new capped collections. In some circumstances, you may use this command to pre-allocate space for an ordinary collection.

Capped collections have maximum size or document counts that prevent them from growing beyond maximum thresholds. All capped collections must specify a maximum size, but may also specify a maximum document count. MongoDB will remove older documents if a collection reaches the maximum size limit before it reaches the maximum document count. Consider the following example:

```
db.createCollection("log", { capped : true, size : 5242880, max : 5000 } )
```

This command creates a collection named `log` with a maximum size of 5 megabytes and a maximum of 5000 documents.

The following command simply pre-allocates a 2 gigabyte, uncapped collection named `people`:

```
db.createCollection("people", { size: 2147483648 })
```

This command provides a wrapper around the database command `create` (page 751). See *Capped Collections* (page 440) for more information about capped collections.

db.currentOp()

db.**currentOp**()

Returns A *document* that contains an array named `inprog`.

The `inprog` array reports the current operation in progress for the database instance. See *Current Operation Reporting* (page 998) for full documentation of the output of `db.currentOp()` (page 846).

`db.currentOp()` (page 846) is only available for users with administrative privileges.

Consider the following JavaScript operations for the `mongo` (page 908) shell that you can use to filter the output of identify specific types of operations:

•Return all pending write operations:

```
db.currentOp().inprog.forEach(
   function(d){
     if(d.waitingForLock && d.lockType != "read")
        printjson(d)
     })
```

•Return the active write operation:

```
db.currentOp().inprog.forEach(
   function(d){
     if(d.active && d.lockType == "write")
        printjson(d)
     })
```

•Return all active read operations:

```
db.currentOp().inprog.forEach(
   function(d){
     if(d.active && d.lockType == "read")
        printjson(d)
     })
```

Warning: Terminate running operations with extreme caution. Only use `db.killOp()` (page 851) to terminate operations initiated by clients and *do not* terminate internal database operations.

db.dropDatabase()

db.**dropDatabase**()

Removes the current database. Does not change the current database, so the insertion of any documents in this database will allocate a fresh set of data files.

db.eval()

db.**eval**(*function*, *arguments*)

The `db.eval()` (page 846) provides the ability to run JavaScript code on the MongoDB server. It is a `mongo` (page 908) shell wrapper around the `eval` (page 755) command. However, unlike the `eval` (page 755) command, the `db.eval()` (page 846) method does not support the `nolock` option.

The method accepts the following parameters:

Parameters

- **function** (*JavaScript*) – A JavaScript function.

  The function need not take any arguments, as in the first example, or may optionally take arguments as in the second:

  ```
  function () {
    // ...
  }


  function (arg1, arg2) {
     // ...
  }
  ```

- **arguments** – A list of arguments to pass to the JavaScript `function` if the function accepts arguments. Omit if the `function` does not take arguments.

Consider the following example of the `db.eval()` (page 846) method:

```
db.eval( function(name, incAmount) {
            var doc = db.myCollection.findOne( { name : name } );

            doc = doc || { name : name , num : 0 , total : 0 , avg : 0 };

            doc.num++;
            doc.total += incAmount;
            doc.avg = doc.total / doc.num;

            db.myCollection.save( doc );
            return doc;
         },
         "<name>", 5 );
```

- The `db` in the function refers to the current database.
- `"<name>"` is the argument passed to the function, and corresponds to the `name` argument.
- `5` is an argument to the function and corresponds to the `incAmount` field.

If you want to use the server's interpreter, you must run `db.eval()` (page 846). Otherwise, the `mongo` (page 908) shell's JavaScript interpreter evaluates functions entered directly into the shell.

If an error occurs, `db.eval()` (page 846) throws an exception. Consider the following invalid function that uses the variable `x` without declaring it as an argument:

```
db.eval( function() { return x + x; }, 3 );
```

The statement will result in the following exception:

```
{
   "errno" : -3,
   "errmsg" : "invoke failed: JS Error: ReferenceError: x is not defined nofile_b:1",
   "ok" : 0
}
```

Warning:

- By default, db.eval() (page 846) takes a global write lock before evaluating the JavaScript function. As a result, db.eval() (page 846) blocks all other read and write operations to the database while the db.eval() (page 846) operation runs. Set nolock to true on the eval (page 755) *command* to prevent the eval (page 755) *command* from taking the global write lock before evaluating the JavaScript. nolock does not impact whether operations within the JavaScript code itself takes a write lock.
- db.eval() (page 846) also takes a JavaScript lock.
- Do not use db.eval() (page 846) for long running operations, as db.eval() (page 846) blocks all other operations. Consider using *other server side code execution options* (page 438).
- You can not use db.eval() (page 846) with *sharded* data. In general, you should avoid using db.eval() (page 846) in *sharded cluster*; nevertheless, it is possible to use db.eval() (page 846) with non-sharded collections and databases stored in *sharded cluster*.
- With authentication (page 947) enabled, db.eval() (page 846) will fail during the operation if you do not have the permission to perform a specified task.

See Also:

Server-side JavaScript (page 438)

db.fsyncLock()

db.**fsyncLock**()

Forces the mongod (page 897) to flush pending all write operations to the disk and locks the *entire* mongod (page 897) instance to prevent additional writes until the user releases the lock with the db.fsyncUnlock() (page 848) command. db.fsyncLock() (page 848) is an administrative command.

This command provides a simple wrapper around a fsync (page 763) database command with the following syntax:

```
{ fsync: 1, lock: true }
```

This function locks the database and create a window for *backup operations* (page 67).

Note: The database cannot be locked with db.fsyncLock() (page 848) while profiling is enabled. You must disable profiling before locking the database with db.fsyncLock() (page 848). Disable profiling using db.setProfilingLevel() (page 854) as follows in the mongo (page 908) shell:

```
db.setProfilingLevel(0)
```

db.fsyncUnlock()

db.**fsyncUnlock**()

Unlocks a mongod (page 897) instance to allow writes and reverses the operation of a db.fsyncLock() (page 848) operation. Typically you will use db.fsyncUnlock() (page 848) following a database *backup operation* (page 67).

db.fsyncUnlock() (page 848) is an administrative command.

db.getCollection()

db.**getCollection**(*name*)

Parameters

- **name** – The name of a collection.

Returns A collection.

Use this command to obtain a handle on a collection whose name might interact with the shell itself, including collections with names that begin with _ or mirror the *database commands* (page 885).

db.getCollectionNames()

`db.getCollectionNames()`

Returns An array containing all collections in the existing database.

db.getLastError()

`db.getLastError()`

Returns The last error message string.

Sets the level of *write concern* for confirming the success of write operations.

See Also:

`getLastError` (page 766) for all options, *Write Concern* (page 124) for a conceptual overview, *Write Operations* (page 123) for information about all write operations in MongoDB, and *Replica Set Write Concern* (page 303) for special considerations related to write concern for replica sets.

db.getLastErrorObj()

`db.getLastErrorObj()`

Returns A full *document* with status information.

db.getMongo()

`db.getMongo()`

Returns The current database connection.

`db.getMongo()` (page 849) runs when the shell initiates. Use this command to test that the `mongo` (page 908) shell has a connection to the proper database instance.

db.getName()

`db.getName()`

Returns the current database name.

db.getPrevError()

db.**getPrevError**()

Returns A status document, containing the errors.

Deprecated since version 1.6. This output reports all errors since the last time the database received a `resetError` (page 792) (also `db.resetError()` (page 853)) command.

This method provides a wrapper around the `getPrevError` (page 768) command.

db.getProfilingLevel()

db.**getProfilingLevel**()

This method provides a wrapper around the database command "`profile` (page 783)" and returns the current profiling level. Deprecated since version 1.8.4: Use `db.getProfilingStatus()` (page 850) for related functionality.

db.getProfilingStatus()

db.**getProfilingStatus**()

Returns The current `profile` (page 783) level and `slowms` (page 950) setting.

db.getReplicationInfo()

db.**getReplicationInfo**()

Returns A status document.

The output reports statistics related to replication.

See Also:

"*Replication Info Reference* (page 997)" for full documentation of this output.

db.getSiblingDB()

db.**getSiblingDB**()

Used to return another database without modifying the `db` variable in the shell environment.

db.help()

db.**help**()

Returns Text output listing common methods on the `db` object.

db.isMaster()

db.**isMaster**()

Returns a status document with fields that includes the `ismaster` field that reports if the current node is the *primary* node, as well as a report of a subset of current replica set configuration.

This function provides a wrapper around the *database command* `isMaster` (page 772)

db.killOp()

db.**killOp**(*opid*)

Parameters

- **opid** – Specify an operation ID.

Terminates the specified operation. Use db.currentOp() (page 846) to find operations and their corresponding ids. See *Current Operation Reporting* (page 998) for full documentation of the output of db.currentOp() (page 846).

Note: You cannot use db.killOp() (page 851) to kill a foreground index build.

Warning: Terminate running operations with extreme caution. Only use db.killOp() (page 851) to terminate operations initiated by clients and *do not* terminate internal database operations.

db.listCommands()

db.**listCommands**()

Provides a list of all database commands. See the "*Database Commands Quick Reference* (page 885)" document for a more extensive index of these options.

db.loadServerScripts()

db.**loadServerScripts**()

db.loadServerScripts() (page 851) loads all scripts in the system.js collection for the current database into the mongo (page 908) shell session.

Documents in the system.js collection have the following prototype form:

```
{ _id : "<name>" , value : <function> } }
```

The documents in the system.js collection provide functions that your applications can use in any JavaScript context with MongoDB in this database. These contexts include $where (page 720) clauses and mapReduce (page 775) operations.

db.logout()

db.**logout**()

Ends the current authentication session. This function has no effect if the current session is not authenticated.

Note: If you're not logged in and using authentication, db.logout() (page 851) has no effect.

---

db.logout() (page 851) function provides a wrapper around the database command logout (page 775).

db.printCollectionStats()

db.**printCollectionStats**()

Provides a wrapper around the db.collection.stats() (page 841) method. Returns statistics from every collection separated by three hyphen characters.

Note: The db.printCollectionStats() (page 851) in the mongo (page 908) shell does **not** return *JSON*. Use db.printCollectionStats() (page 851) for manual inspection, and db.collection.stats() (page 841) in scripts.

See Also:

"*Collection Statistics Reference* (page 980)"

db.printReplicationInfo()

db.**printReplicationInfo**()

Provides a formatted report of the status of a *replica set* from the perspective of the *primary* set member. See the "*Replica Set Status Reference* (page 987)" for more information regarding the contents of this output.

This function will return db.printSlaveReplicationInfo() (page 852) if issued against a *secondary* set member.

Note: The db.printReplicationInfo() (page 852) in the mongo (page 908) shell does **not** return *JSON*. Use db.printReplicationInfo() (page 852) for manual inspection, and rs.status() (page 861) in scripts.

---

db.printShardingStatus()

db.**printShardingStatus**()

Provides a formatted report of the sharding configuration and the information regarding existing chunks in a *sharded cluster*.

Only use db.printShardingStatus() (page 852) when connected to a mongos (page 905) instance.

Note: The db.printCollectionStats() (page 851) in the mongo (page 908) shell does **not** return *JSON*. Use db.printCollectionStats() (page 851) for manual inspection, and *Config Database Contents* (page 1013) in scripts.

See Also:

sh.status() (page 871)

db.printSlaveReplicationInfo()

db.**printSlaveReplicationInfo**()

Provides a formatted report of the status of a *replica set* from the perspective of the *secondary* set member. See the "*Replica Set Status Reference* (page 987)" for more information regarding the contents of this output.

Note: The db.printSlaveReplicationInfo() (page 852) in the mongo (page 908) shell does **not** return *JSON*. Use db.printSlaveReplicationInfo() (page 852) for manual inspection, and rs.status() (page 861) in scripts.

---

db.removeUser()

db.**removeUser**(*username*)

Parameters

- **username** – Specify a database username.

Removes the specified username from the database.

db.repairDatabase()

db.**repairDatabase**()

Warning: In general, if you have an intact copy of your data, such as would exist on a very recent backup or an intact member of a *replica set*, **do not** use `repairDatabase` (page 787) or related options like `db.repairDatabase()` (page 853) in the `mongo` (page 908) shell or *`mongod --repair`* (page 901). Restore from an intact copy of your data.

Note: When using *journaling*, there is almost never any need to run `repairDatabase` (page 787). In the event of an unclean shutdown, the server will be able restore the data files to a pristine state automatically.

`db.repairDatabase()` (page 853) provides a wrapper around the database command `repairDatabase` (page 787), and has the same effect as the run-time option *`mongod --repair`* (page 901) option, limited to *only* the current database. See `repairDatabase` (page 787) for full documentation.

db.resetError()

db.**resetError**()

Deprecated since version 1.6. Resets the error message returned by `db.getPrevError` (page 850) or `getPrevError` (page 768). Provides a wrapper around the `resetError` (page 792) command.

db.runCommand()

db.**runCommand**(*command*)

Parameters

- **command** (*string*) – Specifies a *database command* in the form of a *document*.
- **command** – When specifying a *command* (page 885) as a string, `db.runCommand()` (page 853) transforms the command into the form `{ command: 1 }`.

Provides a helper to run specified *database commands* (page 885). This is the preferred method to issue database commands, as it provides a consistent interface between the shell and drivers.

db.serverBuildInfo()

db.**serverBuildInfo**()

Provides a wrapper around the `buildInfo` (page 742) *database command*. `buildInfo` (page 742) returns a document that contains an overview of parameters used to compile this `mongod` (page 897) instance.

db.serverStatus()

db.**serverStatus**()

Returns a *document* that provides an overview of the database process's state.

This command provides a wrapper around the database command `serverStatus` (page 792).

See Also:

"*Server Status Reference* (page 965)" for complete documentation of the output of this function.

db.setProfilingLevel()

db.**setProfilingLevel**(*level*[, *slowms*])

Parameters

- **level** – Specifies a profiling level, see list of possible values below.
- **slowms** – Optionally modify the threshold for the profile to consider a query or operation "slow."

Modifies the current *database profiler* level. This allows administrators to capture data regarding performance. The database profiling system can impact performance and can allow the server to write the contents of queries to the log, which might have information security implications for your deployment.

The following profiling levels are available:

Level	Setting
0	Off. No profiling.
1	On. Only includes slow operations.
2	On. Includes all operations.

Also configure the `slowms` (page 950) option to set the threshold for the profiler to consider a query "slow." Specify this value in milliseconds to override the default.

This command provides a wrapper around the *database command* `profile` (page 783).

`mongod` (page 897) writes the output of the database profiler to the `system.profile` collection.

`mongod` (page 897) prints information about queries that take longer than the `slowms` (page 950) to the log even when the database profiler is not active.

Note: The database cannot be locked with `db.fsyncLock()` (page 848) while profiling is enabled. You must disable profiling before locking the database with `db.fsyncLock()` (page 848). Disable profiling using `db.setProfilingLevel()` (page 854) as follows in the `mongo` (page 908) shell:

```
db.setProfilingLevel(0)
```

db.shutdownServer()

db.**shutdownServer**()

Shuts down the current `mongod` (page 897) or `mongos` (page 905) process cleanly and safely.

This operation fails when the current database *is not* the *admin database*.

This command provides a wrapper around the `shutdown` (page 795).

db.stats()

db.**stats**(*scale*)

Parameters

- **scale** – Optional. Specifies the scale to deliver results. Unless specified, this command returns all data in bytes.

Returns A *document* that contains statistics reflecting the database system's state.

This function provides a wrapper around the database command "`dbStats` (page 753)". The `scale` option allows you to configure how the `mongo` (page 908) shell scales the sizes of things in the output. For example, specify a `scale` value of `1024` to display kilobytes rather than bytes.

See the "*Database Statistics Reference* (page 979)" document for an overview of this output.

Note: The scale factor rounds values to whole numbers. This can produce unpredictable and unexpected results in some situations.

---

db.version()

db.**version**()

Returns The version of the `mongod` (page 897) instance.

fuzzFile()

fuzzFile(*"filename"*)

Parameters

- **filename** (*string*) – Specify a filename or path to a local file.

Returns null

For internal use.

getHostName()

getHostName()

Returns The hostname of the system running the `mongo` (page 908) shell process.

getMemInfo

getMemInfo()

Returns a document with two fields that report the amount of memory used by the JavaScript shell process. The fields returned are *resident* and *virtual*.

hostname()

hostname()

Returns The hostname of the system running the `mongo` (page 908) shell process.

_isWindows()

_isWindows()

Returns boolean.

Returns "true" if the mongo (page 908) shell is running on a system that is Windows, or "false" if the server is running on a Unix or Linux systems.

listFiles()

listFiles()

Returns an array, containing one document per object in the directory. This function operates in the context of the mongo (page 908) process. The included fields are:

name
Returns a string which contains the name of the object.

isDirectory
Returns true or false if the object is a directory.

size
Returns the size of the object in bytes. This field is only present for files.

load()

load(<*file*>)

Parameters

- **file** (*string*) – Specify a path and file name containing JavaScript.

This native function loads and runs a JavaScript file into the current shell environment. To run JavaScript with the mongo shell, you can either:

- use the "*--eval* (page 909)" option when invoking the shell to evaluate a small amount of JavaScript code, or
- specify a file name with "*mongo* (page 909)". mongo (page 908) will execute the script and then exit. Add the *--shell* (page 908) option to return to the shell after running the command.

Specify files loaded with the `load()` function in relative terms to the current directory of the mongo (page 908) shell session. Check the current directory using the "`pwd()`" function.

ls()

ls()

Returns a list of the files in the current directory.

This function returns with output relative to the current shell session, and does not impact the server.

md5sumFile()

md5sumFile(*"filename"*)

Parameters

- **filename** (*string*) – a file name.

Returns The *md5* hash of the specified file.

Note: The specified filename must refer to a file located on the system running the `mongo` (page 908) shell.

---

mkdir()

mkdir(*"path"*)

Parameters

- **path** (*string*) – A path on the local filesystem.

Creates a directory at the specified path. This command will create the entire path specified, if the enclosing directory or directories do not already exit.

Equivalent to **mkdir -p** with BSD or GNU utilities.

mongo.setSlaveOk()

mongo.**setSlaveOk**()

For the current session, this command permits read operations from non-master (i.e. *slave* or *secondary*) instances. Practically, use this method in the following form:

```
db.getMongo().setSlaveOk()
```

Indicates that "*eventually consistent*" read operations are acceptable for the current application. This function provides the same functionality as `rs.slaveOk()` (page 861).

See the `readPref()` (page 811) method for more fine-grained control over *read preference* (page 306) in the `mongo` (page 908) shell.

pwd()

pwd()

Returns the current directory.

This function returns with output relative to the current shell session, and does not impact the server.

quit()

quit()

Exits the current shell session.

rand()

_rand()

Returns A random number between `0` and `1`.

This function provides functionality similar to the `Math.rand()` function from the standard library.

rawMongoProgramOutput()

rawMongoProgramOutput()
For internal use.

removeFile()

removeFile(*"filename"*)

Parameters

- **filename** (*string*) – Specify a filename or path to a local file.

Returns boolean.

Removes the specified file from the local file system.

resetDbpath()

resetDbpath()
For internal use.

rs.add()

rs.**add**(*hostspec*, *arbiterOnly*)
Specify one of the following forms:

Parameters

- **host** (*string,document*) – Either a string or a document. If a string, specifies a host (and optionally port-number) for a new host member for the replica set; MongoDB will add this host with the default configuration. If a document, specifies any attributes about a member of a replica set.
- **arbiterOnly** (*boolean*) – Optional. If `true`, this host is an arbiter. If the second argument evaluates to `true`, as is the case with some *documents*, then this instance will become an arbiter.

Provides a simple method to add a member to an existing *replica set*. You can specify new hosts in one of two ways:

1. as a "hostname" with an optional port number to use the default configuration as in the *Add a Member to an Existing Replica Set* (page 329) example.
2. as a configuration *document*, as in the *Add a Member to an Existing Replica Set (Alternate Procedure)* (page 330) example.

This function will disconnect the shell briefly and forces a reconnection as the replica set renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.add()` (page 858) provides a wrapper around some of the functionality of the "`replSetReconfig` (page 790)" *database command* and the corresponding shell helper `rs.reconfig()` (page 860). See the *Replica Set Configuration* (page 989) document for full documentation of all replica set configuration options.

Example

To add a `mongod` (page 897) accessible on the default port `27017` running on the host `mongodb3.example.net`, use the following `rs.add()` (page 858) invocation:

```
rs.add('mongodb3.example.net:27017')
```

If `mongodb3.example.net` is an arbiter, use the following form:

```
rs.add('mongodb3.example.net:27017', true)
```

To add `mongodb3.example.net` as a *secondary-only* (page 286) member of set, use the following form of `rs.add()` (page 858):

```
rs.add( { "_id": "3", "host": "mongodbd3.example.net:27017", "priority": 0 } )
```

Replace, `3` with the next unused `_id` value in the replica set. See `rs.conf()` (page 859) to see the existing `_id` values in the replica set configuration document.

See the *Replica Set Configuration* (page 989) and *Replica Set Operation and Management* (page 285) documents for more information.

---

rs.addArb()

`rs.addArb(hostname)`

Parameters

- **host** (*string*) – Specifies a host (and optionally port-number) for a arbiter member for the replica set.

Adds a new *arbiter* to an existing replica set.

This function will disconnect the shell briefly and forces a reconnection as the replica set renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

rs.conf()

`rs.conf()`

Returns a *document* that contains the current *replica set* configuration object.

`rs.config()`

`rs.config()` (page 859) is an alias of `rs.conf()` (page 859).

rs.freeze()

`rs.freeze(seconds)`

Parameters

- **seconds** (*init*) – Specify the duration of this operation.

Forces the current node to become ineligible to become primary for the period specified.

`rs.freeze()` (page 859) provides a wrapper around the *database command* `replSetFreeze` (page 788).

rs.help()

`rs.help()`

Returns a basic help text for all of the *replication* (page 279) related shell functions.

rs.initiate()

rs.**initiate**(*configuration*)

Parameters

- **configuration** – Optional. A *document* that specifies the configuration of a replica set. If not specified, MongoDB will use a default configuration.

Initiates a replica set. Optionally takes a configuration argument in the form of a *document* that holds the configuration of a replica set. Consider the following model of the most basic configuration for a 3-member replica set:

```
{
    _id : <setname>,
     members : [
         {_id : 0, host : <host0>},
         {_id : 1, host : <host1>},
         {_id : 2, host : <host2>},
     ]
}
```

This function provides a wrapper around the "`replSetInitiate` (page 789)" *database command*.

rs.reconfig()

rs.**reconfig**(*configuration*[, *force*])

Parameters

- **configuration** – A *document* that specifies the configuration of a replica set.
- **force** – Optional. Specify `{ force: true }` as the force parameter to force the replica set to accept the new configuration even if a majority of the members are not accessible. Use with caution, as this can lead to *rollback* situations.

Initializes a new *replica set* configuration. This function will disconnect the shell briefly and forces a reconnection as the replica set renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.reconfig()` (page 860) provides a wrapper around the "`replSetReconfig` (page 790)" *database command*.

`rs.reconfig()` (page 860) overwrites the existing replica set configuration. Retrieve the current configuration object with `rs.conf()` (page 859), modify the configuration as needed and then use `rs.reconfig()` (page 860) to submit the modified configuration object.

To reconfigure a replica set, use the following sequence of operations:

```
conf = rs.conf()

// modify conf to change configuration

rs.reconfig(conf)
```

If you want to force the reconfiguration if a majority of the set isn't connected to the current member, or you're issuing the command against a secondary, use the following form:

```
conf = rs.conf()

// modify conf to change configuration
```

```
rs.reconfig(conf, { force: true } )
```

Warning: Forcing a `rs.reconfig()` (page 860) can lead to *rollback* situations and other difficult to recover from situations. Exercise caution when using this option.

See Also:

"*Replica Set Configuration* (page 989)" and "*Replica Set Operation and Management* (page 285)".

rs.remove()

`rs.remove(hostname)`

Parameters

- **hostname** – Specify one of the existing hosts to remove from the current replica set.

Removes the node described by the `hostname` parameter from the current *replica set*. This function will disconnect the shell briefly and forces a reconnection as the *replica set* renegotiates negotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

Note: Before running the `rs.remove()` (page 861) operation, you must *shut down* the replica set member that you're removing. Changed in version 2.2: This procedure is no longer required when using `rs.remove()` (page 861), but it remains good practice.

---

rs.slaveOk()

`rs.slaveOk()`

Provides a shorthand for the following operation:

```
db.getMongo().setSlaveOk()
```

This allows the current connection to allow read operations to run on *secondary* nodes. See the `readPref()` (page 811) method for more fine-grained control over *read preference* (page 306) in the `mongo` (page 908) shell.

rs.status()

`rs.status()`

Returns A *document* with status information.

This output reflects the current status of the replica set, using data derived from the heartbeat packets sent by the other members of the replica set.

This method provides a wrapper around the `replSetGetStatus` (page 788) *database command*.

See Also:

"*Replica Set Status Reference* (page 987)" for documentation of this output.

rs.stepDown()

rs.**stepDown**(*seconds*)

Parameters

- **seconds** (*init*) – Specify the duration of this operation. If not specified the command uses the default value of 60 seconds.

Returns disconnects shell.

Forces the current replica set member to step down as *primary* and then attempt to avoid election as primary for the designated number of seconds. Produces an error if the current node is not primary.

This function will disconnect the shell briefly and forces a reconnection as the *replica set* renegotiates which node will be *primary*. As a result, the shell will display an error even if this command succeeds.

`rs.stepDown()` (page 862) provides a wrapper around the *database command* `replSetStepDown` (page 790).

rs.syncFrom()

rs.**syncFrom**()

New in version 2.2. Provides a wrapper around the `replSetSyncFrom` (page 791), which allows administrators to configure the member of a replica set that the current member will pull data from. Specify the name of the member you want to replicate from in the form of `[hostname]:[port]`.

See `replSetSyncFrom` (page 791) for more details.

run()

run()

For internal use.

runMongoProgram()

runMongoProgram()

For internal use.

runProgram()

runProgram()

For internal use.

sh._adminCommand()

sh.**_adminCommand**(*cmd*, *checkMongos*)

Parameters

- **dbcommand** (*string*) – A database command to run against the `admin` database.
- **checkMongos** (*Boolean*) – Verify whether or not the shell is connected to a `mongos` (page 905) instance.

The sh._adminCommand (page 862) method runs a database command against the admin database of a mongos (page 905) instance.

See Also:

db.runCommand() (page 853)

sh._checkFullName()

sh.**_checkFullName**(*namespace*)

Parameters

- **namespace** (*string*) – Specify a complete namespace.

Throws "name needs to be fully qualified <db>.<collection>"

The sh._checkFullName() (page 863) method verifies that a namespace name is well-formed. If the name has a period . then the sh._checkFullName() (page 863) method exits, otherwise it throws an error.

sh._checkMongos()

sh.**_checkMongos**()

Returns nothing

Throws "not connected to a mongos"

The sh._checkMongos() (page 863) method throws an error message if the mongo (page 908) shell is not connected to a mongos (page 905) instance. Otherwise it exits (no return document or return code).

sh._lastMigration()

sh.**_lastMigration**(*namespace*)

Parameters

- **namespace** (*string*) – The name of a database or collection within the current database.

Returns A document with fields detailing the most recent migration in the specified namespace.

sh._lastMigration() (page 863) returns a document with details about the last migration performed on the database or collection you specify.

Document details:

Fields

- **_id** (*string*) – The id of the migration task
- **server** (*string*) – The name of the server
- **clientAddr** (*string*) – The IP address and port number of the server.
- **time** (*ISODate*) – The time of the last migration.
- **what** (*string*) – The specific type of migration.
- **ns** (*string*) – The complete namespace of the collection affected by the migration.
- **details** (*document*) – A document containing details about the migrated chunk. Includes min and max sub-documents with the bounds of the migrated chunk.

sh.addShard()

sh.**addShard**(*host*)

Parameters

- **host** (*string*) – Specify the hostname of a database instance or a replica set configuration.

Use this method to add a database instance or replica set to a *sharded cluster*. This method must be run on a mongos (page 905) instance. The host parameter can be in any of the following forms:

```
[hostname]
[hostname]:[port]
[set]/[hostname]
[set]/[hostname],[hostname]:port
```

You can specify shards using the hostname, or a hostname and port combination if the shard is running on a non-standard port.

Warning: Do not use localhost for the hostname unless your *configuration server* is also running on localhost.

The optimal configuration is to deploy shards across *replica sets*. To add a shard on a replica set you must specify the name of the replica set and the hostname of at least one member of the replica set. You must specify at least one member of the set, but can specify all members in the set or another subset if desired. sh.addShard() (page 864) takes the following form:

If you specify additional hostnames, all must be members of the same replica set.

```
sh.addShard("set-name/seed-hostname")
```

Example

```
sh.addShard("repl0/mongodb3.example.net:27327")
```

The sh.addShard() (page 864) method is a helper for the addShard (page 739) command. The addShard (page 739) command has additional options which are not available with this helper.

See Also:

- addShard (page 739)
- *Sharded Cluster Administration* (page 368)
- *Add Shards to a Cluster* (page 387)
- *Remove Shards from an Existing Sharded Cluster* (page 400)

sh.addShardTag()

sh.**addShardTag**(*shard*, *tag*)

New in version 2.2.

Parameters

- **shard** (*string*) – Specifies the name of the shard that you want to give a specific tag.
- **tag** (*string*) – Specifies the name of the tag that you want to add to the shard.

`sh.addShardTag()` (page 864) associates a shard with a tag or identifier. MongoDB uses these identifiers to direct *chunks* that fall within a tagged range to specific shards.

`sh.addTagRange()` (page 865) associates chunk ranges with tag ranges.

Always issue `sh.addShardTag()` (page 864) when connected to a `mongos` (page 905) instance.

Example

The following example adds three tags, `NYC`, `LAX`, and `NRT`, to three shards:

```
sh.addShardTag("shard0000", "NYC")
sh.addShardTag("shard0001", "LAX")
sh.addShardTag("shard0002", "NRT")
```

See Also:

- `sh.addTagRange()` (page 865) and
- `sh.removeShardTag()` (page 869)

sh.addTagRange()

`sh.addTagRange`(*namespace*, *minimum*, *maximum*, *tag*)

New in version 2.2.

Parameters

- **namespace** (*string*) – Specifies the namespace, in the form of `<database>.<collection>` of the sharded collection that you would like to tag.
- **minimum** (*document*) – Specifies the minimum value of the *shard key* range to include in the tag. Specify the minimum value in the form of `<fieldname>:<value>`. This value must be of the same BSON type or types as the shard key.
- **maximum** (*document*) – Specifies the maximum value of the shard key range to include in the tag. Specify the maximum value in the form of `<fieldname>:<value>`. This value must be of the same BSON type or types as the shard key.
- **tag** (*string*) – Specifies the name of the tag to attach the range specified by the `minimum` and `maximum` arguments to.

`sh.addTagRange()` (page 865) attaches a range of values of the shard key to a shard tag created using the `sh.addShardTag()` (page 864) method. Use this operation to ensure that the documents that exist within the specified range exist on shards that have a matching tag.

Always issue `sh.addTagRange()` (page 865) when connected to a `mongos` (page 905) instance.

Note: If you add a tag range to a collection using `sh.addTagRange()` (page 865), and then later drop the collection or its database, MongoDB does not remove tag association. If you later create a new collection with the same name, the old tag association will apply to the new collection.

Example

Given a shard key of `{STATE:1,ZIP:1}`, create a tag range covering ZIP codes in New York State:

```
sh.addTagRange( "exampledb.collection",
        {STATE: "NY", ZIP: {minKey:1}},
        {STATE:"NY", ZIP: {maxKey:1}},
        "NY"
        )
```

See Also:

sh.addShardTag() (page 864), sh.removeShardTag() (page 869)

sh.disableBalancing()

sh.**disableBalancing**(*collection*)

Parameters

- **collection** (*string*) – The name of a collection.

sh.disableBalancing() (page 866) disables the balancer for the specified sharded collection.

See Also:

- sh.enableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.enableBalancing()

sh.**enableBalancing**(*collection*)

Parameters

- **collection** (*string*) – The name of a collection.

sh.enableBalancing() (page 866) enables the balancer for the specified sharded collection.

See Also:

- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)

- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.enableSharding()

sh.**enableSharding**(*database*)

Parameters

- **database** (*string*) – Specify a database name to shard.

Enables sharding on the specified database. This does not automatically shard any collections, but makes it possible to begin sharding collections using sh.shardCollection() (page 870).

See Also:

sh.shardCollection() (page 870)

sh.getBalancerHost()

sh.**getBalancerHost**()

Returns String in form *hostname*:*port*

sh.getBalancerHost() (page 867) returns the name of the server that is running the balancer.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.getBalancerState()

sh.**getBalancerState**()

Returns boolean

sh.getBalancerState() (page 867) returns `true` when the *balancer* is enabled and false if the balancer is disabled. This does not reflect the current state of balancing operations: use sh.isBalancerRunning() (page 868) to check the balancer's current state.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)

- sh.getBalancerHost() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.help()

`sh.help()`

Returns a basic help text for all sharding related shell functions.

sh.isBalancerRunning()

`sh.isBalancerRunning()`

Returns boolean

Returns true if the *balancer* process is currently running and migrating chunks and false if the balancer process is not running. Use `sh.getBalancerState()` (page 867) to determine if the balancer is enabled or disabled.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.moveChunk()

`sh.moveChunk(`*collection*, *query*, *destination*`)`

Parameters

- **collection** (*string*) – Specify the sharded collection containing the chunk to migrate.
- **query** – Specify a query to identify documents in a specific chunk. Typically specify the *shard key* for a document as the query.
- **destination** (*string*) – Specify the name of the shard that you wish to move the designated chunk to.

Moves the chunk containing the documents specified by the `query` to the shard described by `destination`.

This function provides a wrapper around the `moveChunk` (page 782). In most circumstances, allow the *balancer* to automatically migrate *chunks*, and avoid calling `sh.moveChunk()` (page 868) directly.

See Also:

"`moveChunk` (page 782)" and "*Sharding* (page 363)" for more information.

sh.removeShardTag()

`sh.`**`removeShardTag`**(*shard*, *tag*)

New in version 2.2.

Parameters

- **shard** (*string*) – Specifies the name of the shard that you want to remove a tag from.
- **tag** (*string*) – Specifies the name of the tag that you want to remove from the shard.

Removes the association between a tag and a shard.

Always issue `sh.removeShardTag()` (page 869) when connected to a `mongos` (page 905) instance.

See Also:

`sh.addShardTag()` (page 864), `sh.addTagRange()` (page 865)

sh.setBalancerState()

`sh.`**`setBalancerState`**(*state*)

Parameters

- **state** (*boolean*) – `true` enables the balancer if disabled, and `false` disables the balancer.

Enables or disables the *balancer*. Use `sh.getBalancerState()` (page 867) to determine if the balancer is currently enabled or disabled and `sh.isBalancerRunning()` (page 868) to check its current state.

See Also:

- `sh.enableBalancing()` (page 866)
- `sh.disableBalancing()` (page 866)
- `sh.getBalancerHost()` (page 867)
- `sh.getBalancerState()` (page 867)
- `sh.isBalancerRunning()` (page 868)
- `sh.startBalancer()` (page 871)
- `sh.stopBalancer()` (page 871)
- `sh.waitForBalancer()` (page 872)
- `sh.waitForBalancerOff()` (page 872)

sh.shardCollection()

sh.**shardCollection**(*collection*, *key*, *unique*)

Parameters

- **collection** (*string*) – The namespace of the collection to shard.
- **key** (*document*) – A *document* containing a *shard key* that the sharding system uses to *partition* and distribute objects among the shards.
- **unique** (*boolean*) – When true, the `unique` option ensures that the underlying index enforces uniqueness so long as the unique index is a prefix of the shard key.

Shards the named collection, according to the specified *shard key*. Specify shard keys in the form of a *document*. Shard keys may refer to a single document field, or more typically several document fields to form a "compound shard key."

See Also:

`Size of Sharded Collection`

sh.splitAt()

sh.**splitAt**(*namespace*, *query*)

Parameters

- **namespace** (*string*) – Specify the namespace (i.e. "`<database>.<collection>`") of the sharded collection that contains the chunk to split.
- **query** (*document*) – Specify a query to identify a document in a specific chunk. Typically specify the *shard key* for a document as the query.

Splits the chunk containing the document specified by the `query` as if that document were at the "middle" of the collection, even if the specified document is not the actual median of the collection. Use this command to manually split chunks unevenly. Use the "`sh.splitFind()` (page 870)" function to split a chunk at the actual median.

In most circumstances, you should leave chunk splitting to the automated processes within MongoDB. However, when initially deploying a *sharded cluster* it is necessary to perform some measure of *pre-splitting* using manual methods including `sh.splitAt()` (page 870).

sh.splitFind()

sh.**splitFind**(*namespace*, *query*)

Parameters

- **namespace** (*string*) – Specify the namespace (i.e. "`<database>.<collection>`") of the sharded collection that contains the chunk to split.
- **query** – Specify a query to identify a document in a specific chunk. Typically specify the *shard key* for a document as the query.

Splits the chunk containing the document specified by the `query` at its median point, creating two roughly equal chunks. Use `sh.splitAt()` (page 870) to split a collection in a specific point.

In most circumstances, you should leave chunk splitting to the automated processes. However, when initially deploying a *sharded cluster* it is necessary to perform some measure of *pre-splitting* using manual methods including `sh.splitFind()` (page 870).

sh.startBalancer()

sh.**startBalancer**(*timeout*, *interval*)

Parameters

- **timeout** (*integer*) – Milliseconds to wait.
- **interval** (*integer*) – Milliseconds to sleep each cycle of waiting.

The sh.startBalancer() (page 871) enables the balancer in a sharded cluster and waits for balancing to initiate.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.status()

sh.**status**()

Returns a formatted report of the status of the *sharded cluster*, including data regarding the distribution of chunks.

sh.stopBalancer()

sh.**stopBalancer**(*timeout*, *interval*)

Parameters

- **timeout** (*integer*) – Milliseconds to wait.
- **interval** (*integer*) – Milliseconds to sleep each cycle of waiting.

The sh.stopBalancer() (page 871) disables the balancer in a sharded cluster and waits for balancing to complete.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)

- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.waitForBalancer() (page 872)
- sh.waitForBalancerOff() (page 872)

sh.waitForBalancer()

sh.**waitForBalancer**(*onOrNot*, *timeout*, *interval*)

Parameters

- **onOrNot** (*Boolean*) – Whether to wait for the lock to be on (true) or off (false).
- **timeout** (*integer*) – Milliseconds to wait.
- **interval** (*integer*) – Milliseconds to sleep.

sh.waitForBalancer() (page 872) is an internal method that waits for a change in the state of the balancer.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)
- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancerOff() (page 872)

sh.waitForBalancerOff()

sh.**waitForBalancerOff**()

Parameters

- **timeout** (*integer*) – Milliseconds to wait.
- **interval** (*integer*) – Milliseconds to sleep.

sh.waitForBalancerOff() (page 872) is an internal method that waits until the balancer is not running.

See Also:

- sh.enableBalancing() (page 866)
- sh.disableBalancing() (page 866)
- sh.getBalancerHost() (page 867)
- sh.getBalancerState() (page 867)
- sh.isBalancerRunning() (page 868)
- sh.setBalancerState() (page 869)

- sh.startBalancer() (page 871)
- sh.stopBalancer() (page 871)
- sh.waitForBalancer() (page 872)

sh.waitForDLock()

sh.**waitForDLock**(*lockId*, *onOrNot*, *timeout*, *interval*)

Parameters

- **lockId** (*string*) – The name of the distributed lock.
- **onOrNot** (*Boolean*) – Optional, whether to wait for the lock to be on (true) or off (false).
- **timeout** (*integer*) – Milliseconds to wait.
- **interval** (*integer*) – Milliseconds to sleep in each waiting cycle.

sh.waitForDLock() (page 873) is an internal method that waits until the specified distributed lock is changes state.

sh.waitForPingChange()

sh.**waitForPingChange**(*activepings*, *timeout*, *interval*)

Parameters

- **activepings** (*array*) – An array of active pings from the config.mongos collection.
- **timeout** (*integer*) – Milliseconds to wait for a change in ping state.
- **interval** (*integer*) – Milliseconds to sleep in each waiting cycle.

sh.waitForPingChange() (page 873) waits for a change in ping state of the one of the activepings.

_srand()

_srand()
For internal use.

startMongoProgram()

_startMongoProgram()
For internal use.

stopMongoProgram()

stopMongoProgram()
For internal use.

stopMongoProgramByPid()

stopMongoProgramByPid()
For internal use.

stopMongod()

stopMongod()
For internal use.

version()

version()

Returns The version of the mongo (page 908) shell.

waitMongoProgramOnPort()

waitMongoProgramOnPort()
For internal use.

waitProgram()

waitProgram()
For internal use.

61.2 MongoDB and SQL Interface Comparisons

The following documents provide mappings between MongoDB concepts and statements and SQL concepts and statements.

61.2.1 SQL to MongoDB Mapping Chart

In addition to the charts that follow, you might want to consider the *Frequently Asked Questions* (page 635) section for a selection of common questions about MongoDB.

Executables

The following table presents the MySQL/Oracle executables and the corresponding MongoDB executables.

	MySQL/Oracle	MongoDB
Database Server	mysqld/oracle	*mongod* (page 897)
Database Client	mysql/sqlplus	*mongo* (page 908)

Terminology and Concepts

The following table presents the various SQL terminology and concepts and the corresponding MongoDB terminology and concepts.

SQL Terms/Concepts	MongoDB Terms/Concepts
database	*database*
table	*collection*
row	*document* or *BSON* document
column	*field*
index	*index*
table joins	embedded documents and linking
primary key Specify any unique column or column combination as primary key.	*primary key* In MongoDB, the primary key is automatically set to the *_id* field.
aggregation (e.g. group by)	aggregation framework See the *SQL to Aggregation Framework Mapping Chart* (page 879).

Examples

The following table presents the various SQL statements and the corresponding MongoDB statements. The examples in the table assume the following conditions:

- The SQL examples assume a table named `users`.
- The MongoDB examples assume a collection named `users` that contain documents of the following prototype:

```
{
  _id: ObjectID("509a8fb2f3f4948bd2f983a0"),
  user_id: "abc123",
  age: 55,
  status: 'A'
}
```

Create and Alter

The following table presents the various SQL statements related to table-level actions and the corresponding MongoDB statements.

SQL Schema Statements	MongoDB Schema Statements	Reference

`CREATE TABLE users (`
`  id MEDIUMINT NOT NULL`
`  AUTO_INCREMENT,`
`  user_id Varchar(30),`
`  age Number,`
`  status char(1),`
`  PRIMARY KEY (id)`
`)`
	Implicitly created on first `insert` (page 830) operation. The primary key `_id` is automatically added if `_id` field is not specified.
	`db.users.insert( {`
	`  user_id: "abc123",`
	`  age: 55,`
	`  status: "A"`
	`} )`
	However, you can also explicitly create a collection:
	`db.createCollection("users")`
		See `insert()` (page 830) and `createCollection()` (page 845) for more information.

`ALTER TABLE users`
`ADD join_date DATETIME`
	Collections do not describe or enforce the structure of its documents; i.e. there is no structural alteration at the collection level.
	However, at the document level, `update()` (page 842) operations can add fields to existing documents using the `$set` (page 716) operator.
	`db.users.update(`
	`  { },`
	`  { $set: { join_date: new Date() } },`
	`  { multi: true }`
	`)`
		See the *Data Modeling Considerations for MongoDB Applications* (page 131), `update()` (page 842), and `$set` (page 716) for more information on changing the structure of documents in a collection.

`ALTER TABLE users`
`DROP COLUMN join_date`
	Collections do not describe or enforce the structure of its documents; i.e. there is no structural alteration at the collection level.
	However, at the document level, `update()` (page 842) operations can remove fields from documents using the `$unset` (page 720) operator.
	`db.users.update(`
	`  { },`
	`  { $unset: { join_date: "" } },`
	`  { multi: true }`
	`)`
		See *Data Modeling Considerations for MongoDB Applications* (page 131), `update()` (page 842), and `$unset` (page 720) for more information on changing the structure of documents in a collection.

`CREATE INDEX idx_user_id_asc` `ON users(user_id)`	`db.users.ensureIndex( { user_id: 1 } )`	See `ensureIndex()` (page 819) and *indexes* (page 241) for more information.

`CREATE INDEX`
`  idx_user_id_asc_age_desc`
`ON users(user_id, age DESC)`
	`db.users.ensureIndex( { user_id: 1, age: -1 } )`	See `ensureIndex()` (page 819) and *indexes* (page 241) for more information.

`DROP TABLE users`	`db.users.drop()`	See `drop()` (page 818) for more information.

Insert

The following table presents the various SQL statements related to inserting records into tables and the corresponding MongoDB statements.

SQL INSERT Statements	MongoDB insert() Statements	Reference
`INSERT INTO users(user_id, age, status) VALUES ("bcd001", 45, "A")`	`db.users.insert( { user_id: "bcd001", age: 45, status: "A" } )`	See `insert()` (page 830) for more information.

Select

The following table presents the various SQL statements related to reading records from tables and the corresponding MongoDB statements.

SQL SELECT Statements	MongoDB find() Statements	Reference
`SELECT * FROM users`	`db.users.find()`	See `find()` (page 820) for more information.
`SELECT id, user_id, status FROM users`	`db.users.find( { }, { user_id: 1, status: 1 } )`	See `find()` (page 820) for more information.
`SELECT user_id, status FROM users`	`db.users.find( { }, { user_id: 1, status: 1, _id: 0 } )`	See `find()` (page 820) for more information.
`SELECT * FROM users WHERE status = "A"`	`db.users.find( { status: "A" } )`	See `find()` (page 820) for more information.
`SELECT user_id, status FROM users WHERE status = "A"`	`db.users.find( { status: "A" }, { user_id: 1, status: 1, _id: 0 } )`	See `find()` (page 820) for more information.
`SELECT * FROM users WHERE status != "A"`	`db.users.find( { status: { $ne: "A" } } )`	See `find()` (page 820) and `$ne` (page 704) for more information.
`SELECT * FROM users WHERE status = "A" AND age = 50`	`db.users.find( { status: "A", age: 50 } )`	See `find()` (page 820) and `$and` (page 692) for more information.
`SELECT * FROM users WHERE status = "A" OR age = 50`	`db.users.find( { $or: [ { status: "A" } , { age: 50 } ] } )`	See `find()` (page 820) and `$or` (page 707) for more information.
`SELECT * FROM users WHERE age > 25`	`db.users.find( { age: { $gt: 25 } } )`	See `find()` (page 820) and `$gt` (page 697) for more information.
`SELECT * FROM users WHERE age < 25`	`db.users.find( { age: { $lt: 25 } } )`	See `find()` (page 820) and `$lt` (page 700) for more information.
`SELECT * FROM users WHERE age > 25 AND age <= 50`	`db.users.find( { age: { $gt: 25, $lte: 50 } } )`	See `find()` (page 820), `$gt` (page 697), and `$lte` (page 700) for more information.
`SELECT * FROM users WHERE user_id like "%bc%"`	`db.users.find( { user_id: /bc/ } )`	See `find()` (page 820) and `$regex` (page 713) for more information.

Update Records

The following table presents the various SQL statements related to updating existing records in tables and the corresponding MongoDB statements.

SQL Update Statements	MongoDB update() Statements	Reference
`UPDATE users SET status = "C" WHERE age > 25`	`db.users.update( { age: { $gt: 25 } }, { $set: { status: "C" } }, { multi: true } )`	See `update()` (page 842), `$gt` (page 697), and `$set` (page 716) for more information.
`UPDATE users SET age = age + 3 WHERE status = "A"`	`db.users.update( { status: "A" } , { $inc: { age: 3 } }, { multi: true } )`	See `update()` (page 842), `$inc` (page 699), and `$set` (page 716) for more information.

Delete Records

The following table presents the various SQL statements related to deleting records from tables and the corresponding MongoDB statements.

SQL Delete Statements	MongoDB remove() Statements	Reference
`DELETE FROM users WHERE status = "D"`	`db.users.remove( { status: "D" } )`	See `remove()` (page 838) for more information.
`DELETE FROM users`	`db.users.remove( )`	See `remove()` (page 838) for more information.

61.2.2 SQL to Aggregation Framework Mapping Chart

The *aggregation framework* (page 195) allows MongoDB to provide native aggregation capabilities that corresponds to many common data aggregation operations in SQL. If you're new to MongoDB you might want to consider the *Frequently Asked Questions* (page 635) section for a selection of common questions.

The following table provides an overview of common SQL aggregation terms, functions, and concepts and the corresponding MongoDB *aggregation operators* (page 212):

SQL Terms, Functions, and Concepts	MongoDB Aggregation Operators
WHERE	`$match` (page 731)
GROUP BY	`$group` (page 728)
HAVING	`$match` (page 731)
SELECT	`$project` (page 733)
ORDER BY	`$sort` (page 735)
LIMIT	`$limit` (page 730)
SUM()	`$sum`
COUNT()	`$sum`
join	No direct corresponding operator; *however*, the `$unwind` (page 737) operator allows for somewhat similar functionality, but with fields embedded within the document.

Examples

The following table presents a quick reference of SQL aggregation statements and the corresponding MongoDB statements. The examples in the table assume the following conditions:

- The SQL examples assume *two* tables, `orders` and `order_lineitem` that join by the `order_lineitem.order_id` and the `orders.id` columns.
- The MongoDB examples assume *one* collection `orders` that contain documents of the following prototype:

```
{
  cust_id: "abc123",
  ord_date: ISODate("2012-11-02T17:04:11.102Z"),
  status: 'A',
  price: 50,
  items: [ { sku: "xxx", qty: 25, price: 1 },
           { sku: "yyy", qty: 25, price: 1 } ]
}
```

- The MongoDB statements prefix the names of the fields from the *documents* in the collection `orders` with a `$` character when they appear as operands to the aggregation operations.

SQL Example	MongoDB Example	Description
`SELECT COUNT(*) AS count FROM orders`	`db.orders.aggregate( [ { $group: { _id: null, count: { $sum: 1 } } } ] )`	Count all records from `orders`
`SELECT SUM(price) AS total FROM orders`	`db.orders.aggregate( [ { $group: { _id: null, total: { $sum: "$price" } } } ] )`	Sum the `price` field from `orders`
`SELECT cust_id, SUM(price) AS total FROM orders GROUP BY cust_id`	`db.orders.aggregate( [ { $group: { _id: "$cust_id", total: { $sum: "$price" } } } ] )`	For each unique `cust_id`, sum the `price` field.
`SELECT cust_id, SUM(price) AS total FROM orders GROUP BY cust_id ORDER BY total`	`db.orders.aggregate( [ { $group: { _id: "$cust_id", total: { $sum: "$price" } } }, { $sort: { total: 1 } } ] )`	For each unique `cust_id`, sum the `price` field, results sorted by sum.
`SELECT cust_id, ord_date, SUM(price) AS total FROM orders GROUP BY cust_id, ord_date`	`db.orders.aggregate( [ { $group: { _id: { cust_id: "$cust_id", ord_date: "$ord_date" }, total: { $sum: "$price" } } } ] )`	For each unique `cust_id`, `ord_date` grouping, sum the `price` field.
`SELECT cust_id, count(*) FROM orders GROUP BY cust_id HAVING count(*) > 1`	`db.orders.aggregate( [ { $group: { _id: "$cust_id", count: { $sum: 1 } } }, { $match: { count: { $gt: 1 } } } ] )`	For `cust_id` with multiple records, return the `cust_id` and the corresponding record count.
`SELECT cust_id, ord_date, SUM(price) AS total FROM orders GROUP BY cust_id, ord_date HAVING total > 250`	`db.orders.aggregate( [ { $group: { _id: { cust_id: "$cust_id", ord_date: "$ord_date" }, total: { $sum: "$price" } } }, { $match: { total: { $gt: 250 } } } ] )`	For each unique `cust_id`, `ord_date` grouping, sum the `price` field and return only where the sum is greater than 250.
`SELECT cust_id, SUM(price) as total FROM orders WHERE status = 'A' GROUP BY cust_id`	`db.orders.aggregate( [ { $match: { status: 'A' } }, { $group: { _id: "$cust_id", total: { $sum: "$price" } } } ] )`	For each unique `cust_id` with status `A`, sum the `price` field.
`SELECT cust_id, SUM(price) as total FROM orders WHERE status = 'A' GROUP BY cust_id HAVING total > 250`	`db.orders.aggregate( [ { $match: { status: 'A' } }, { $group: { _id: "$cust_id", total: { $sum: "$price" } } }, { $match: { total: { $gt: 250 } } } ] )`	For each unique `cust_id` with status `A`, sum the `price` field and return only where the sum is greater than 250.
`SELECT cust_id,`	`db.orders.aggregate( [`	For each unique `cust_id`, sum the

61.3 Quick Reference Material

For this reference material in another form, consider the following quick reference and interface overview pages:

61.3.1 Query, Update, and Projection Operators Quick Reference

This document contains a list of all *operators* used with MongoDB in version 2.2. See *Core MongoDB Operations (CRUD)* (page 109) for a higher level overview of the operations that use these operators, and *Query, Update, Projection, and Aggregation Operators* (page 691) for a more condensed index of these operators.

Operators

- Query Selectors (page 882)
  - Comparison (page 882)
  - Logical (page 883)
  - Element (page 883)
  - JavaScript (page 883)
  - Geospatial (page 883)
  - Array (page 884)
- Update (page 884)
  - Fields (page 884)
  - Array (page 884)
  - Bitwise (page 884)
  - Isolation (page 884)
- Projection (page 885)

Query Selectors

Comparison

Note: To express `equal to` (e.g. =) in the MongoDB query language, use JSON `{ key:value }` structure. Consider the following prototype:

```
db.collection.find( { field: value } )
```

For example:

```
db.collection.find( { a: 42 } )
```

This query selects all the documents the where the `a` field holds a value of `42`.

- `$all` (page 691)
- `$gt` (page 697)
- `$gte` (page 697)
- `$in` (page 698)
- `$lt` (page 700)
- `$lte` (page 700)

- $ne (page 704)
- $nin (page 705)

You may combine comparison operators to specify ranges:

```
db.collection.find( { field: { $gt: value1, $lt: value2 } } );
```

This statement returns all documents with `field` between `value1` and `value2`.

Note: Fields containing arrays match conditional operators, if only one item matches. Therefore, the following query:

```
db.collection.find( { field: { $gt:0, $lt:2 } } );
```

Will match a document that contains the following field:

```
{ field: [-1,3] }
```

Logical

- $and (page 692)
- $nor (page 706)
- $not (page 707)
- $or (page 707)

Element

- $exists (page 695)
- $mod (page 703)
- $type (page 718)

JavaScript

- $regex (page 713)
- $where (page 720)

Geospatial

- $near (page 704)
- $within (page 721)
- $nearSphere (page 705)

Use the following operators within the context of $near (page 704):

- $maxDistance (page 702)

Use the following operators within the context of $within (page 721):

- $center (page 694)

- $box (page 693)
- $polygon (page 709)
- $centerSphere (page 694)
- $uniqueDocs (page 719)

Array

- $elemMatch (page 695)
- $size (page 717)

Update

Fields

- $inc (page 699)
- $rename (page 714)
- $set (page 716)
- $unset (page 720)

Array

- $ (page 710)
- $addToSet (page 691)
- $pop (page 709)
- $pullAll (page 711)
- $pull (page 711)
- $pushAll (page 712)
- $push (page 711)

Bitwise

- $bit (page 693)

Isolation

- $isolated (page 699)

Projection

- $ (page 724)
- $elemMatch (page 722)
- $slice (page 726)

61.3.2 Meta Query Operator Quick Reference

Introduction

In addition to the *MongoDB Query Operators* (page 882), there are a number of "meta" operators that you can modify the output or behavior of a query. On the server, MongoDB treats the query and the options as a single object. The mongo (page 908) shell and driver interfaces may provide *cursor methods* (page 890) that wrap these options. When possible, use these methods; otherwise, you can add these options using either of the following syntax:

```
db.collection.find( { <query> } )._addSpecial( <option> )
db.collection.find( { $query: { <query> }, <option> } )
```

Modifiers

Many of these operators have corresponding *methods in the shell* (page 890). These methods provide a straightforward and user-friendly interface and are the preferred way to add these options.

- $comment (page 695)
- $explain (page 696)
- $hint (page 698)
- $maxScan (page 702)
- $max (page 701)
- $min (page 702)
- $orderby (page 709)
- $returnKey (page 716)
- $showDiskLoc (page 717)
- $snapshot (page 717)

61.3.3 Database Commands Quick Reference

All command documentation lined below describes the commands and available parameters, provides a document template or prototype for each command. Some command documentation also includes the relevant mongo (page 908) shell helpers. See *Database Commands* (page 739) for a list of all commands.

User Commands

Aggregation Commands

- aggregate (page 740)

- count (page 750)
- distinct (page 753)
- eval (page 755)
- findAndModify (page 758)
- group (page 769)
- mapReduce (page 775)

Replication Commands

See Also:

"*Replica Set Fundamental Concepts* (page 279)" for more information regarding replication.

- replSetFreeze (page 788)
- replSetGetStatus (page 788)
- replSetInitiate (page 789)
- replSetReconfig (page 790)
- replSetSyncFrom (page 791)
- resync (page 792)

Sharding Commands

See Also:

Sharding (page 363) for more information about MongoDB's sharding functionality.

- addShard (page 739)
- enableSharding (page 755)
- listShards (page 774)
- removeShard (page 785)
- shardCollection (page 794)
- shardingState (page 795)

Geospatial Commands

- geoNear (page 765)
- geoSearch (page 765)

Collection Commands

- cloneCollectionAsCapped (page 744)
- cloneCollection (page 743)
- collMod (page 744)

- collStats (page 745)
- convertToCapped (page 748)
- create (page 751)
- drop (page 754)
- emptycapped (page 755)
- renameCollection (page 786)

Administration Commands

- clone (page 743)
- compact (page 746)
- copydb (page 749)
- dropDatabase (page 754)
- dropIndexes (page 755)
- fsync (page 763)
- getParameter (page 768)
- logRotate (page 775)
- logout (page 775)
- repairDatabase (page 787)
- setParameter (page 793)
- shutdown (page 795)
- touch (page 798)

Diagnostic Commands

- buildInfo (page 742)
- connPoolStats (page 748)
- cursorInfo (page 752)
- dbStats (page 753)
- forceerror (page 763)
- getCmdLineOpts (page 766)
- getLastError (page 766)
- getLog (page 767)
- getPrevError (page 768)
- isMaster (page 772)
- listCommands (page 774)
- listDatabases (page 774)
- ping (page 783)

- profile (page 783)
- resetError (page 792)
- serverStatus (page 792)
- top (page 798)
- validate (page 799)

Other Commands

- filemd5 (page 758)
- reIndex (page 784)

mongos Commands

- flushRouterConfig (page 763)
- isdbgrid (page 773)
- movePrimary (page 783)
- split (page 796)

Internal Commands

- applyOps (page 741)
- authenticate (page 741)
- availableQueryOptions (page 741)
- captrunc (page 742)
- checkShardingIndex (page 742)
- clean (page 742)
- closeAllDatabases (page 744)
- connPoolSync (page 748)
- copydbgetnonce (page 750)
- dataSize (page 752)
- dbHash (page 752)
- diagLogging (page 753)
- driverOIDTest (page 754)
- features (page 758)
- geoWalk (page 766)
- getShardMap (page 768)
- getShardVersion (page 768)
- getnonce (page 768)
- getoptime (page 768)

- godinsert (page 769)
- handshake (page 772)
- _isSelf (page 773)
- mapreduce.shardedfinish (page 782)
- medianKey (page 782)
- _migrateClone (page 782)
- moveChunk (page 782)
- netstat (page 783)
- _recvChunkAbort (page 785)
- _recvChunkCommit (page 785)
- _recvChunkStart (page 785)
- _recvChunkStatus (page 785)
- replSetElect (page 788)
- replSetFresh (page 788)
- replSetGetRBID (page 788)
- replSetHeartbeat (page 789)
- replSetMaintenance (page 789)
- replSetTest (page 792)
- setShardVersion (page 794)
- _skewClockCommand (page 796)
- sleep (page 796)
- splitChunk (page 797)
- splitVector (page 797)
- _testDistLockWithSkew (page 797)
- _testDistLockWithSyncCluster (page 798)
- _transferMods (page 799)
- unsetSharding (page 799)
- whatsmyuri (page 799)
- writebacklisten (page 800)
- writeBacksQueued (page 799)

61.3.4 mongo Shell JavaScript Quick Reference

Methods

- Data Manipulation (page 890)
  - Query and Update Methods (page 890)
  - Cursor Methods (page 890)
  - Data Aggregation Methods (page 891)
- Administrative Functions (page 891)
  - Database Methods (page 891)
  - Collection Methods (page 892)
  - Sharding Methods (page 893)
  - Replica Set Methods (page 893)
- Native Shell Methods (page 894)
- Non-User Functions and Methods (page 895)
  - Deprecated Methods (page 895)
  - Native Methods (page 895)
  - Internal Methods (page 895)

Data Manipulation

Query and Update Methods

- `db.collection.find()` (page 820)
- `db.collection.findAndModify()` (page 822)
- `db.collection.findOne()` (page 825)
- `db.collection.insert()` (page 830)
- `db.collection.save()` (page 840)
- `db.collection.update()` (page 842)

Cursor Methods

Call cursor methods on cursors to modify how MongoDB returns objects to the cursor.

- `cursor.count()` (page 804)
- `cursor.explain()` (page 805)
- `cursor.forEach()` (page 806)
- `cursor.hasNext()` (page 806)
- `cursor.hint()` (page 806)
- `cursor.limit()` (page 807)
- `cursor.map()` (page 807)
- `cursor.next()` (page 811)
- `cursor.objsLeftInBatch()` (page 811)
- `cursor.readPref()` (page 811)
- `cursor.showDiskLoc()` (page 811)

- cursor.size() (page 812)
- cursor.skip() (page 812)
- cursor.snapshot() (page 812)
- cursor.sort() (page 813)

Data Aggregation Methods

- db.collection.aggregate() (page 815)
- db.collection.group() (page 828)
- db.collection.mapReduce() (page 832)

Administrative Functions

Database Methods

- db.addUser() (page 814)
- db.auth() (page 814)
- db.cloneDatabase() (page 815)
- db.commandHelp() (page 844)
- db.copyDatabase() (page 844)
- db.createCollection() (page 845)
- db.currentOp() (page 846)
- db.dropDatabase() (page 846)
- db.eval() (page 846)
- db.fsyncLock() (page 848)
- db.fsyncUnlock() (page 848)
- db.getCollection() (page 848)
- db.getCollectionNames() (page 849)
- db.getLastError() (page 849)
- db.getLastErrorObj() (page 849)
- db.getMongo() (page 849)
- db.getName() (page 849)
- db.getProfilingLevel() (page 850)
- db.getProfilingStatus() (page 850)
- db.getSiblingDB() (page 850)
- db.killOp() (page 851)
- db.listCommands() (page 851)
- db.loadServerScripts() (page 851)

- db.logout() (page 851)
- db.printCollectionStats() (page 851)
- db.removeUser() (page 853)
- db.repairDatabase() (page 853)
- db.runCommand() (page 853)
- db.serverBuildInfo() (page 853)
- db.serverStatus() (page 854)
- db.setProfilingLevel() (page 854)
- db.shutdownServer() (page 854)
- db.stats() (page 855)
- db.version() (page 855)

Collection Methods

These methods operate on collection objects. Also consider the "*Query and Update Methods* (page 890)" and "*Cursor Methods* (page 890)" documentation for additional methods that you may use with collection objects.

Note: Call these methods on a *collection* object in the shell (i.e. `db.collection.[method]()`, where `collection` is the name of the collection) to produce the documented behavior.

- db.collection.dataSize() (page 817)
- db.collection.distinct() (page 817)
- db.collection.drop() (page 818)
- db.collection.dropIndex() (page 818)
- db.collection.dropIndexes() (page 819)
- db.collection.ensureIndex() (page 819)
- db.collection.getIndexes() (page 826)
- db.collection.getShardDistribution() (page 826)
- db.collection.getShardVersion() (page 828)
- db.collection.reIndex() (page 838)
- db.collection.remove() (page 838)
- db.collection.renameCollection() (page 839)
- db.collection.stats() (page 841)
- db.collection.storageSize() (page 841)
- db.collection.totalIndexSize() (page 842)
- db.collection.totalSize() (page 842)
- db.collection.validate() (page 844)
- Mongo.getDB() (page 801)

Sharding Methods

See Also:

The "*Sharded Cluster Overview* (page 365)" page for more information on the sharding technology and using MongoDB's *sharded clusters*.

- `db.printShardingStatus()` (page 852)
- `sh.addShard()` (page 864)
- `sh.addShardTag()` (page 864)
- `sh.addTagRange()` (page 865)
- `sh._adminCommand()` (page 862)
- `sh._checkMongos()` (page 863)
- `sh._checkFullName()` (page 863)
- `sh.disableBalancing()` (page 866)
- `sh.enableBalancing()` (page 866)
- `sh.enableSharding()` (page 867)
- `sh.getBalancerHost()` (page 867)
- `sh.help()` (page 868)
- `sh._lastMigration()` (page 863)
- `sh.isBalancerRunning()` (page 868)
- `sh.moveChunk()` (page 868)
- `sh.removeShardTag()` (page 869)
- `sh.setBalancerState()` (page 869)
- `sh.shardCollection()` (page 870)
- `sh.splitAt()` (page 870)
- `sh.splitFind()` (page 870)
- `sh.startBalancer()` (page 871)
- `sh.status()` (page 871)
- `sh.stopBalancer()` (page 871)
- `sh.waitForBalancerOff()` (page 872)
- `sh.waitForBalancer()` (page 872)
- `sh.waitForDLock()` (page 873)
- `sh.waitForPingChange()` (page 873)

Replica Set Methods

See Also:

Replica Set Fundamental Concepts (page 279) for more information regarding replication.

- `db.getReplicationInfo()` (page 850)

- db.isMaster() (page 850)
- db.printReplicationInfo() (page 852)
- db.printSlaveReplicationInfo() (page 852)
- mongo.setSlaveOk() (page 857)
- rs.add() (page 858)
- rs.addArb() (page 859)
- rs.conf() (page 859)
- rs.freeze() (page 859)
- rs.help() (page 859)
- rs.initiate() (page 860)
- rs.reconfig() (page 860)
- rs.remove() (page 861)
- rs.slaveOk() (page 861)
- rs.status() (page 861)
- rs.stepDown() (page 862)
- rs.syncFrom() (page 862)

Native Shell Methods

These methods provide a number of low level and internal functions that may be useful in the context of some advanced operations in the shell. The JavaScript standard library is accessible in the mongo (page 908) shell.

- Date() (page 800)
- cat()
- cd()
- fuzzFile() (page 855)
- getHostName() (page 855)
- getMemInfo() (page 855)
- hostname()
- listFiles() (page 856)
- load()
- ls()
- md5sumFile() (page 856)
- mkdir()
- pwd()
- quit()
- removeFile() (page 858)

Non-User Functions and Methods

Deprecated Methods

- db.getPrevError() (page 850)
- db.resetError() (page 853)

Native Methods

- _isWindows() (page 856)
- rand()
- srand()

Internal Methods

These methods are accessible in the shell but exist to support other functionality in the environment. Do not call these methods directly.

- _startMongoProgram() (page 873)
- clearRawMongoProgramOutput() (page 803)
- copyDbpath() (page 803)
- rawMongoProgramOutput() (page 858)
- resetDbpath() (page 858)
- run()
- runMongoProgram() (page 862)
- runProgram() (page 862)
- stopMongoProgram() (page 873)
- stopMongoProgramByPid() (page 873)
- stopMongod() (page 874)
- waitMongoProgramOnPort() (page 874)
- waitProgram() (page 874)

Additionally consider the following quick reference material located in other sections of the manual:

- *mongo Shell Quick Reference* (page 479) for a mongo (page 908) shell quick reference.
- *Aggregation Framework Reference* (page 211) for all *aggregation* (page 193) operators;

CHAPTER 62

Architecture and Components

62.1 MongoDB Package Components

62.1.1 Core Processes

The core components in the MongoDB package are: `mongod` (page 897), the core database process; `mongos` (page 905) the controller and query router for *sharded clusters*; and `mongo` (page 908) the interactive MongoDB Shell.

mongod

Synopsis

`mongod` (page 897) is the primary daemon process for the MongoDB system. It handles data requests, manages data format, and performs background management operations.

This document provides a complete overview of all command line options for `mongod` (page 897). These options are primarily useful for testing purposes. In common operation, use the *configuration file options* (page 944) to control the behavior of your database, which is fully capable of all operations described below.

Options

mongod

--help, -h
Returns a basic help and usage text.

--version
Returns the version of the `mongod` (page 897) daemon.

--config `<filename>`**, -f** `<filename>`
Specifies a configuration file, that you can use to specify runtime-configurations. While the options are equivalent and accessible via the other command line arguments, the configuration file is the preferred method for runtime configuration of mongod. See the "*Configuration File Options* (page 944)" document for more information about these options.

--verbose, -v
Increases the amount of internal reporting returned on standard output or in the log file specified by *--logpath* (page 898). Use the -v form to control the level of verbosity by including the option multiple times, (e.g. -vvvvv.)

--quiet
Runs the mongod (page 897) instance in a quiet mode that attempts to limit the amount of output. This option suppresses:

- output from *database commands*, including drop (page 754), dropIndexes (page 755), diagLogging (page 753), validate (page 799), and clean (page 742).
- replication activity.
- connection accepted events.
- connection closed events.

--port <port>
Specifies a TCP port for the mongod (page 897) to listen for client connections. By default mongod (page 897) listens for connections on port 27017.

UNIX-like systems require root privileges to use ports with numbers lower than 1024.

--bind_ip <ip address>
The IP address that the mongod (page 897) process will bind to and listen for connections. By default mongod (page 897) listens for connections all interfaces. You may attach mongod (page 897) to any interface; however, when attaching mongod (page 897) to a publicly accessible interface ensure that you have implemented proper authentication and/or firewall restrictions to protect the integrity of your database.

--maxConns <number>
Specifies the maximum number of simultaneous connections that mongod (page 897) will accept. This setting will have no effect if it is higher than your operating system's configured maximum connection tracking threshold.

Note: You cannot set maxConns (page 946) to a value higher than *20000*.

--objcheck
Forces the mongod (page 897) to validate all requests from clients upon receipt to ensure that invalid objects are never inserted into the database. Enabling this option will produce some performance impact, and is not enabled by default.

--logpath <path>
Specify a path for the log file that will hold all diagnostic logging information.

Unless specified, mongod (page 897) will output all log information to the standard output. Additionally, unless you also specify *--logappend* (page 898), the logfile will be overwritten when the process restarts.

Note: The behavior of the logging system may change in the near future in response to the SERVER-4499 case.

--logappend
When specified, this option ensures that mongod (page 897) appends new entries to the end of the logfile rather than overwriting the content of the log when the process restarts.

--syslog
New in version 2.1.0. Sends all logging output to the host's *syslog* system rather than to standard output or a log file as with *--logpath* (page 898).

> **Warning:** You cannot use *--syslog* (page 898) with *--logpath* (page 898).

--pidfilepath <path>
Specify a file location to hold the "*PID*" or process ID of the mongod (page 897) process. Useful for tracking the mongod (page 897) process in combination with the *mongod --fork* (page 899) option.

Without a specified *--pidfilepath* (page 899) option, mongos (page 905) creates no PID file.

--keyFile <file>
Specify the path to a key file to store authentication information. This option is only useful for the connection between replica set members.

See Also:

"*Replica Set Security* (page 294)" and "*Replica Set Operation and Management* (page 285)."

--nounixsocket
Disables listening on the UNIX socket. Unless set to false, mongod (page 897) and mongos (page 905) provide a UNIX-socket.

--unixSocketPrefix <path>
Specifies a path for the UNIX socket. Unless this option has a value, mongod (page 897) and mongos (page 905), create a socket with the http://docs.mongodb.org/v2.2/tmp as a prefix.

--fork
Enables a *daemon* mode for mongod (page 897) that runs the process to the background. This is the normal mode of operation, in production and production-like environments, but may *not* be desirable for testing.

--auth
Enables database authentication for users connecting from remote hosts. Configure users via the *mongo shell* (page 908). If no users exist, the localhost interface will continue to have access to the database until the you create the first user.

See the *Security and Authentication* (page 87) page for more information regarding this functionality.

--cpu
Forces mongod (page 897) to report the percentage of CPU time in write lock. mongod (page 897) generates output every four seconds. MongoDB writes this data to standard output or the logfile if using the logpath (page 946) option.

--dbpath <path>
Specify a directory for the mongod (page 897) instance to store its data. Typical locations include: http://docs.mongodb.org/v2.2/srv/mongodb, http://docs.mongodb.org/v2.2/var/lib/mongodb or http://docs.mongodb.org/v2.2/opt/mongodb

Unless specified, mongod (page 897) will look for data files in the default http://docs.mongodb.org/v2.2/data/db directory. (Windows systems use the \data\db directory.) If you installed using a package management system. Check the http://docs.mongodb.org/v2.2/etc/mongodb.conf file provided by your packages to see the configuration of the dbpath (page 947).

--diaglog <value>
Creates a very verbose, *diagnostic log* for troubleshooting and recording various errors. MongoDB writes these log files in the dbpath (page 947) directory in a series of files that begin with the string diaglog and end with the initiation time of the logging as a hex string.

The specified value configures the level of verbosity. Possible values, and their impact are as follows.

Value	Setting
0	off. No logging.
1	Log write operations.
2	Log read operations.
3	Log both read and write operations.
7	Log write and some read operations.

You can use the mongosniff (page 938) tool to replay this output for investigation. Given a typical diaglog file, located at http://docs.mongodb.org/v2.2/data/db/diaglog.4f76a58c, you might use a command in the following form to read these files:

```
mongosniff --source DIAGLOG /data/db/diaglog.4f76a58c
```

--diaglog (page 899) is for internal use and not intended for most users.

Warning: Setting the diagnostic level to 0 will cause mongod (page 897) to stop writing data to the *diagnostic log* file. However, the mongod (page 897) instance will continue to keep the file open, even if it is no longer writing data to the file. If you want to rename, move, or delete the diagnostic log you must cleanly shut down the mongod (page 897) instance before doing so.

--directoryperdb

Alters the storage pattern of the data directory to store each database's files in a distinct folder. This option will create directories within the *--dbpath* (page 899) named for each directory.

Use this option in conjunction with your file system and device configuration so that MongoDB will store data on a number of distinct disk devices to increase write throughput or disk capacity.

--journal

Enables operation journaling to ensure write durability and data consistency. mongod (page 897) enables journaling by default on 64-bit builds of versions after 2.0.

--journalOptions <arguments>

Provides functionality for testing. Not for general use, and may affect database integrity.

--journalCommitInterval <value>

Specifies the maximum amount of time for mongod (page 897) to allow between journal operations. The default value is 100 milliseconds, while possible values range from 2 to 300 milliseconds. Lower values increase the durability of the journal, at the expense of disk performance.

To force mongod (page 897) to commit to the journal more frequently, you can specify j:true. When a write operation with j:true pending, mongod (page 897) will reduce journalCommitInterval (page 948) to a third of the set value.

--ipv6

Specify this option to enable IPv6 support. This will allow clients to connect to mongod (page 897) using IPv6 networks. mongod (page 897) disables IPv6 support by default in mongod (page 897) and all utilities.

--jsonp

Permits *JSONP* access via an HTTP interface. Consider the security implications of allowing this activity before enabling this option.

--noauth

Disable authentication. Currently the default. Exists for future compatibility and clarity.

--nohttpinterface

Disables the HTTP interface.

--nojournal

Disables the durability journaling. By default, mongod (page 897) enables journaling in 64-bit versions after v2.0.

--noprealloc
Disables the preallocation of data files. This will shorten the start up time in some cases, but can cause significant performance penalties during normal operations.

--noscripting
Disables the scripting engine.

--notablescan
Forbids operations that require a table scan.

--nssize <value>
Specifies the default size for namespace files (i.e `.ns`). This option has no impact on the size of existing namespace files. The maximum size is 2047 megabytes.

The default value is 16 megabytes; this provides for approximately 24,000 namespaces. Each collection, as well as each index, counts as a namespace.

--profile <level>
Changes the level of database profiling, which inserts information about operation performance into output of `mongod` (page 897) or the log file. The following levels are available:

Level	Setting
0	Off. No profiling.
1	On. Only includes slow operations.
2	On. Includes all operations.

Profiling is off by default. Database profiling can impact database performance. Enable this option only after careful consideration.

--quota
Enables a maximum limit for the number data files each database can have. When running with *--quota* (page 901), there are a maximum of 8 data files per database. Adjust the quota with the *--quotaFiles* (page 901) option.

--quotaFiles <number>
Modify limit on the number of data files per database. This option requires the *--quota* (page 901) setting. The default value for *--quotaFiles* (page 901) is 8.

--rest
Enables the simple *REST* API.

--repair
Runs a repair routine on all databases. This is equivalent to shutting down and running the `repairDatabase` (page 787) database command on all databases.

Warning: In general, if you have an intact copy of your data, such as would exist on a very recent backup or an intact member of a *replica set*, **do not** use `repairDatabase` (page 787) or related options like `db.repairDatabase()` (page 853) in the `mongo` (page 908) shell or *mongod --repair* (page 901). Restore from an intact copy of your data.

Note: When using *journaling*, there is almost never any need to run `repairDatabase` (page 787). In the event of an unclean shutdown, the server will be able restore the data files to a pristine state automatically.

Changed in version 2.1.2. If you run the repair option *and* have data in a journal file, `mongod` (page 897) will refuse to start. In these cases you should start `mongod` (page 897) without the *--repair* (page 901) option to allow `mongod` (page 897) to recover data from the journal. This will complete more quickly and will result in a more consistent and complete data set.

To continue the repair operation despite the journal files, shut down mongod (page 897) cleanly and restart with the --repair (page 901) option.

Note: --repair (page 901) copies data from the source data files into new data files in the repairpath (page 950), and then replaces the original data files with the repaired data files. *If* repairpath (page 950) is on the same device as dbpath (page 947), you *may* interrupt a mongod (page 897) running --repair (page 901) without affecting the integrity of the data set.

--repairpath <path>
Specifies the root directory containing MongoDB data files, to use for the --repair (page 901) operation. Defaults to a _tmp directory within the dbpath (page 947).

--slowms <value>
Defines the value of "slow," for the --profile (page 901) option. The database logs all slow queries to the log, even when the profiler is not turned on. When the database profiler is on, mongod (page 897) the profiler writes to the system.profile collection. See the profile (page 783) command for more information on the database profiler.

--smallfiles
Enables a mode where MongoDB uses a smaller default file size. Specifically, --smallfiles (page 902) reduces the initial size for data files and limits them to 512 megabytes. --smallfiles (page 902) also reduces the size of each *journal* files from 1 gigabyte to 128 megabytes.

Use --smallfiles (page 902) if you have a large number of databases that each holds a small quantity of data. --smallfiles (page 902) can lead your mongod (page 897) to create a large number of files, which may affect performance for larger databases.

--shutdown
Used in *control scripts*, the --shutdown (page 902) will cleanly and safely terminate the mongod (page 897) process. When invoking mongod (page 897) with this option you must set the --dbpath (page 899) option either directly or by way of the *configuration file* (page 944) and the --config (page 897) option.

--shutdown (page 902) is only available on Linux systems.

--syncdelay <value>
mongod (page 897) writes data very quickly to the journal, and lazily to the data files. --syncdelay (page 902) controls how much time can pass before MongoDB flushes data to the *database files* via an *fsync* operation. The default setting is 60 seconds. In almost every situation you should not set this value and use the default setting.

The serverStatus (page 792) command reports the background flush thread's status via the backgroundFlushing (page 972) field.

syncdelay (page 951) has no effect on the journal (page 948) files or *journaling* (page 41).

> **Warning:** If you set --syncdelay (page 902) to 0, MongoDB will not sync the memory mapped files to disk. Do not set this value on production systems.

--sysinfo
Returns diagnostic system information and then exits. The information provides the page size, the number of physical pages, and the number of available physical pages.

--upgrade
Upgrades the on-disk data format of the files specified by the --dbpath (page 899) to the latest version, if needed.

This option only affects the operation of mongod (page 897) if the data files are in an old format.

Note: In most cases you should **not** set this value, so you can exercise the most control over your upgrade process. See the MongoDB release notes (on the download page) for more information about the upgrade process.

--traceExceptions
For internal diagnostic use only.

Replication Options

--replSet <setname>
Use this option to configure replication with replica sets. Specify a setname as an argument to this set. All hosts must have the same set name.

See Also:

"*Replication* (page 277)," "*Replica Set Operation and Management* (page 285)," and "*Replica Set Configuration* (page 989)"

--oplogSize <value>
Specifies a maximum size in megabytes for the replication operation log (e.g. *oplog*.) By mongod (page 897) creates an *oplog* based on the maximum amount of space available. For 64-bit systems, the op log is typically 5% of available disk space.

Once the mongod (page 897) has created the oplog for the first time, changing *--oplogSize* (page 903) will not affect the size of the oplog.

--fastsync
In the context of *replica set* replication, set this option if you have seeded this member with a snapshot of the *dbpath* of another member of the set. Otherwise the mongod (page 897) will attempt to perform an initial sync, as though the member were a new member.

Warning: If the data is not perfectly synchronized *and* mongod (page 897) starts with fastsync (page 952), then the secondary or slave will be permanently out of sync with the primary, which may cause significant consistency problems.

--replIndexPrefetch
New in version 2.2. You must use *--replIndexPrefetch* (page 903) in conjunction with replSet (page 952). The default value is all and available options are:

- none
- all
- _id_only

By default *secondary* members of a *replica set* will load all indexes related to an operation into memory before applying operations from the oplog. You can modify this behavior so that the secondaries will only load the _id index. Specify _id_only or none to prevent the mongod (page 897) from loading *any* index into memory.

Master-Slave Replication These options provide access to conventional master-slave database replication. While this functionality remains accessible in MongoDB, replica sets are the preferred configuration for database replication.

--master
Configures mongod (page 897) to run as a replication *master*.

--slave
Configures mongod (page 897) to run as a replication *slave*.

--source <host><:port>
For use with the *--slave* (page 903) option, the --source option designates the server that this instance will replicate.

--only <arg>
For use with the *--slave* (page 903) option, the --only option specifies only a single *database* to replicate.

--slavedelay <value>
For use with the *--slave* (page 903) option, the --slavedelay option configures a "delay" in seconds, for this slave to wait to apply operations from the *master* node.

--autoresync
For use with the *--slave* (page 903) option. When set, *--autoresync* (page 904) option allows this slave to automatically resync if it is more than 10 seconds behind the master. This setting may be problematic if the *--oplogSize* (page 903) specifies a too small oplog. If the *oplog* is not large enough to store the difference in changes between the master's current state and the state of the slave, this instance will forcibly resync itself unnecessarily. When you set the autoresync (page 953) option to false, the slave will not attempt an automatic resync more than once in a ten minute period.

Sharding Cluster Options

--configsvr
Declares that this mongod (page 897) instance serves as the *config database* of a sharded cluster. When running with this option, clients will not be able to write data to any database other than config and admin. The default port for a mongod (page 897) with this option is 27019 and the default *--dbpath* (page 899) directory is http://docs.mongodb.org/v2.2/data/configdb, unless specified. Changed in version 2.2: *--configsvr* (page 904) also sets *--smallfiles* (page 902). Do not use *--configsvr* (page 904) with *--replSet* (page 903) or *--shardsvr* (page 904). Config servers cannot be a shard server or part of a *replica set*.

--shardsvr
Configures this mongod (page 897) instance as a shard in a partitioned cluster. The default port for these instances is 27018. The only effect of *--shardsvr* (page 904) is to change the port number.

--noMoveParanoia
Disables a "paranoid mode" for data writes for chunk migration operation. See the *chunk migration* (page 380) and moveChunk (page 782) command documentation for more information.

By default mongod (page 897) will save copies of migrated chunks on the "from" server during migrations as "paranoid mode." Setting this option disables this paranoia.

Usage

In common usage, the invocation of mongod (page 897) will resemble the following in the context of an initialization or control script:

```
mongod --config /etc/mongodb.conf
```

See the "*Configuration File Options* (page 944)" for more information on how to configure mongod (page 897) using the configuration file.

mongos

Synopsis

mongos (page 905) for "MongoDB Shard," is a routing service for MongoDB shard configurations that processes queries from the application layer, and determines the location of this data in the *sharded cluster*, in order to complete

these operations. From the perspective of the application, a mongos (page 905) instance behaves identically to any other MongoDB instance.

Note: Changed in version 2.1. Some aggregation operations using the aggregate (page 740) will cause mongos (page 905) instances to require more CPU resources than in previous versions. This modified performance profile may dictate alternate architecture decisions if you use the *aggregation framework* extensively in a sharded environment.

See Also:

Sharding (page 363) and *Sharded Cluster Overview* (page 365).

Options

mongos

--help, -h
Returns a basic help and usage text.

--version
Returns the version of the mongod (page 897) daemon.

--config <filename>, **-f** <filename>
Specifies a configuration file, that you can use to specify runtime-configurations. While the options are equivalent and accessible via the other command line arguments, the configuration file is the preferred method for runtime configuration of mongod. See the "*Configuration File Options* (page 944)" document for more information about these options.

Not all configuration options for mongod (page 897) make sense in the context of mongos (page 905).

--verbose, -v
Increases the amount of internal reporting returned on standard output or in the log file specified by *--logpath* (page 906). Use the -v form to control the level of verbosity by including the option multiple times, (e.g. -vvvvv.)

--quiet
Runs the mongos (page 905) instance in a quiet mode that attempts to limit the amount of output.

--port <port>
Specifies a TCP port for the mongos (page 905) to listen for client connections. By default mongos (page 905) listens for connections on port 27017.

UNIX-like systems require root access to access ports with numbers lower than 1024.

--bind_ip <ip address>
The IP address that the mongos (page 905) process will bind to and listen for connections. By default mongos (page 905) listens for connections all interfaces. You may attach mongos (page 905) to any interface; however, when attaching mongos (page 905) to a publicly accessible interface ensure that you have implemented proper authentication and/or firewall restrictions to protect the integrity of your database.

--maxConns <number>
Specifies the maximum number of simultaneous connections that mongos (page 905) will accept. This setting will have no effect if the value of this setting is higher than your operating system's configured maximum connection tracking threshold.

This is particularly useful for mongos (page 905) if you have a client that creates a number of collections but allows them to timeout rather than close the collections. When you set maxConns (page 946), ensure the value is slightly higher than the size of the connection pool or the total number of connections to prevent erroneous connection spikes from propagating to the members of a *shard* cluster.

Note: You cannot set `maxConns` (page 946) to a value higher than *20000*.

--objcheck
Forces the `mongos` (page 905) to validate all requests from clients upon receipt to ensure that invalid objects are never inserted into the database. This option has a performance impact, and is not enabled by default.

--logpath <path>
Specify a path for the log file that will hold all diagnostic logging information.

Unless specified, `mongos` (page 905) will output all log information to the standard output. Additionally, unless you also specify *--logappend* (page 906), the logfile will be overwritten when the process restarts.

--logappend
Specify to ensure that `mongos` (page 905) appends additional logging data to the end of the logfile rather than overwriting the content of the log when the process restarts.

--syslog
New in version 2.1.0. Sends all logging output to the host's *syslog* system rather than to standard output or a log file as with *--logpath* (page 906).

Warning: You cannot use *--syslog* (page 906) with *--logpath* (page 906).

--pidfilepath <path>
Specify a file location to hold the "*PID*" or process ID of the `mongos` (page 905) process. Useful for tracking the `mongos` (page 905) process in combination with the *mongos --fork* (page 906) option.

Without a specified *--pidfilepath* (page 906) option, `mongos` (page 905) creates no PID file.

--keyFile <file>
Specify the path to a key file to store authentication information. This option is only useful for the connection between `mongos` (page 905) instances and components of the *sharded cluster*.

See Also:

Sharded Cluster Security Considerations (page 371)

--nounixsocket
Disables listening on the UNIX socket. Without this option `mongos` (page 905) creates a UNIX socket.

--unixSocketPrefix <path>
Specifies a path for the UNIX socket. Unless specified, `mongos` (page 905) creates a socket in the `http://docs.mongodb.org/v2.2/tmp` path.

--fork
Enables a *daemon* mode for `mongod` (page 897) which forces the process to the background. This is the normal mode of operation, in production and production-like environments, but may *not* be desirable for testing.

--configdb <config1>,<config2><:port>,<config3>
Set this option to specify a configuration database (i.e. *config database*) for the *sharded cluster*. You must specify either 1 configuration server or 3 configuration servers, in a comma separated list.

Note: `mongos` (page 905) instances read from the first *config server* in the list provided. All `mongos` (page 905) instances **must** specify the hosts to the *--configdb* (page 906) setting in the same order.

If your configuration databases reside in more that one data center, order the hosts in the *--configdb* (page 906) argument so that the config database that is closest to the majority of your `mongos` (page 905) instances is first servers in the list.

Warning: Never remove a config server from the `--configdb` (page 906) parameter, even if the config server or servers are not available, or offline.

--test
This option is for internal testing use only, and runs unit tests without starting a `mongos` (page 905) instance.

--upgrade
This option updates the meta data format used by the *config database*.

--chunkSize <value>
The value of the `--chunkSize` (page 907) determines the size of each *chunk*, *in megabytes*, of data distributed around the *sharded cluster*. The default value is 64 megabytes, which is the ideal size for chunks in most deployments: larger chunk size can lead to uneven data distribution, smaller chunk size often leads to inefficient movement of chunks between nodes. However, in some circumstances it may be necessary to set a different chunk size.

This option *only* sets the chunk size when initializing the cluster for the first time. If you modify the run-time option later, the new value will have no effect. See the "*Modify Chunk Size* (page 394)" procedure if you need to change the chunk size on an existing sharded cluster.

--ipv6
Enables IPv6 support to allow clients to connect to `mongos` (page 905) using IPv6 networks. MongoDB disables IPv6 support by default in `mongod` (page 897) and all utilities.

--jsonp
Permits *JSONP* access via an HTTP interface. Consider the security implications of allowing this activity before enabling this option.

--noscripting
Disables the scripting engine.

--nohttpinterface
New in version 2.1.2. Disables the HTTP interface.

--localThreshold
New in version 2.2. `--localThreshold` (page 907) affects the logic that `mongos` (page 905) uses when selecting *replica set* members to pass read operations to from clients. Specify a value to `--localThreshold` (page 907) in milliseconds. The default value is `15`, which corresponds to the default value in all of the client *drivers* (page 435).

When `mongos` (page 905) receives a request that permits reads to *secondary* members, the `mongos` (page 905) will:

- find the member of the set with the lowest ping time.
- construct a list of replica set members that is within a ping time of 15 milliseconds of the nearest suitable member of the set.

  If you specify a value for `--localThreshold` (page 907), `mongos` (page 905) will construct the list of replica members that are within the latency allowed by this value.
- The `mongos` (page 905) will select a member to read from at random from this list.

The ping time used for a set member compared by the `--localThreshold` (page 907) setting is a moving average of recent ping times, calculated, at most, every 10 seconds. As a result, some queries may reach members above the threshold until the `mongos` (page 905) recalculates the average.

See the *Member Selection* (page 310) section of the *read preference* (page 306) documentation for more information.

--noAutoSplit

New in version 2.0.7. *--noAutoSplit* (page 907) prevents mongos (page 905) from automatically inserting metadata splits in a *sharded collection*. If set on all mongos (page 905), this will prevent MongoDB from creating new chunks as the data in a collection grows.

Because any mongos (page 905) in a cluster can create a split, to totally disable splitting in a cluster you must set *--noAutoSplit* (page 907) on all mongos (page 905).

> **Warning:** With *--noAutoSplit* (page 907) enabled, the data in your sharded cluster may become imbalanced over time. Enable with caution.

mongo

Description

mongo

mongo (page 908) is an interactive JavaScript shell interface to MongoDB, which provides a powerful interface for systems administrators as well as a way for developers to test queries and operations directly with the database. mongo (page 908) also provides a fully functional JavaScript environment for use with a MongoDB. This document addresses the basic invocation of the mongo (page 908) shell and an overview of its usage.

See Also:

In additional to this page, also consider the documentation in the *Using the mongo Shell* (page 463) section of the manual.

Synopsis

```
mongo [-shell] [-nodb] [-norc] [-quiet] [-port <port>] [-host <host>] [-eval <JavaScript>]
```

Interface

Options

--shell

Enables the shell interface after evaluating a *JavaScript* file. If you invoke the mongo (page 908) command and specify a JavaScript file as an argument, or use *--eval* (page 909) to specify JavaScript on the command line, the *--shell* (page 908) option provides the user with a shell prompt after the file finishes executing.

--nodb

Prevents the shell from connecting to any database instances. Later, to connect to a database within the shell, see *Opening New Connections* (page 477).

--norc

Prevents the shell from sourcing and evaluating `~/.mongorc.js` on start up.

--quiet

Silences output from the shell during the connection process.

--port <port>

Specifies the port where the mongod (page 897) or mongos (page 905) instance is listening. Unless specified mongo (page 908) connects to mongod (page 897) instances on port 27017, which is the default mongod (page 897) port.

--host <hostname>
specifies the host where the mongod (page 897) or mongos (page 905) is running to connect to as <hostname>. By default mongo (page 908) will attempt to connect to a MongoDB process running on the localhost.

--eval <javascript>
Evaluates a JavaScript expression specified as an argument to this option. mongo (page 908) does not load its own environment when evaluating code: as a result many options of the shell environment are not available.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance. Use in conjunction with the *--password* (page 909) option to supply a password. If you specify a username and password but the default database or the specified database do not require authentication, mongo (page 908) will exit with an exception.

--password <password>, **-p** <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *--username* (page 909) option to supply a username. If you specify a *--username* (page 909) without the *--password* (page 909) option, mongo (page 908) will prompt for a password interactively, if the mongod (page 897) or mongos (page 905) requires authentication.

--help, -h
Returns a basic help and usage text.

--version
Returns the version of the shell.

--verbose
Increases the verbosity of the output of the shell during the connection process.

--ipv6
Enables IPv6 support that allows mongo (page 908) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongo (page 908), disable IPv6 support by default.

<db address>
Specifies the "database address" of the database to connect to. For example:

```
mongo admin
```

The above command will connect the mongo (page 908) shell to the *admin database* on the local machine. You may specify a remote database instance, with the resolvable hostname or IP address. Separate the database name from the hostname using a http://docs.mongodb.org/v2.2/ character. See the following examples:

```
mongo mongodb1.example.net
mongo mongodb1/admin
mongo 10.8.8.10/test
```

<file.js>
Specifies a JavaScript file to run and then exit. Must be the last option specified. Use the *--shell* (page 908) option to return to a shell after the file finishes running.

Files ~/.dbshell

mongo (page 908) maintains a history of commands in the .dbshell file.

Note: mongo (page 908) does not recorded interaction related to authentication in the history file, including authenticate (page 741) and db.addUser() (page 814).

> **Warning:** Versions of Windows `mongo.exe` earlier than 2.2.0 will save the *.dbshell* file in the `mongo.exe` working directory.

`~/.mongorc.js`

> `mongo` (page 908) will read the `.mongorc.js` file from the home directory of the user invoking `mongo` (page 908). In the file, users can define variables, customize the `mongo` (page 908) shell prompt, or update information that they would like updated every time they launch a shell. If you use the shell to evaluate a JavaScript file or expression either on the command line with *`--eval`* (page 909) or by specifying *a .js file to mongo* (page 909), `mongo` (page 908) will read the `.mongorc.js` file *after* the JavaScript has finished processing.
>
> Specify the *`--norc`* (page 908) option to disable reading `.mongorc.js`.

`http://docs.mongodb.org/v2.2/tmp/mongo_edit<time_t>.js`

> Created by `mongo` (page 908) when editing a file. If the file exists `mongo` (page 908) will append an integer from `1` to `10` to the time value to attempt to create a unique file.

`%TEMP%mongo_edit<time_t>.js`

> Created by `mongo.exe` on Windows when editing a file. If the file exists `mongo` (page 908) will append an integer from `1` to `10` to the time value to attempt to create a unique file.

Environment

`EDITOR`

> Specifies the path to an editor to use with the `edit` shell command. A JavaScript variable `EDITOR` will override the value of `EDITOR` (page 910).

`HOME`

> Specifies the path to the home directory where `mongo` (page 908) will read the `.mongorc.js` file and write the `.dbshell` file.

`HOMEDRIVE`

> On Windows systems, `HOMEDRIVE` (page 910) specifies the path the directory where `mongo` (page 908) will read the `.mongorc.js` file and write the `.dbshell` file.

`HOMEPATH`

> Specifies the Windows path to the home directory where `mongo` (page 908) will read the `.mongorc.js` file and write the `.dbshell` file.

Keyboard Shortcuts

The `mongo` (page 908) shell supports the following keyboard shortcuts: [1]

Keybinding	Function
Up arrow	Retrieve previous command from history
Down-arrow	Retrieve next command from history
Home	Go to beginning of the line
End	Go to end of the line
Tab	Autocomplete method/command
Left-arrow	Go backward one character
Right-arrow	Go forward one character
Ctrl-left-arrow	Go backward one word

Continued on next page

[1] MongoDB accommodates multiple keybinding. Since 2.0, `mongo` (page 908) includes support for basic emacs keybindings.

Table 62.1 – continued from previous page

Keybinding	Function
Ctrl-right-arrow	Go forward one word
Meta-left-arrow	Go backward one word
Meta-right-arrow	Go forward one word
Ctrl-A	Go to the beginning of the line
Ctrl-B	Go backward one character
Ctrl-C	Exit the `mongo` (page 908) shell
Ctrl-D	Delete a char (or exit the `mongo` (page 908) shell)
Ctrl-E	Go to the end of the line
Ctrl-F	Go forward one character
Ctrl-G	Abort
Ctrl-J	Accept/evaluate the line
Ctrl-K	Kill/erase the line
Ctrl-L or type `cls`	Clear the screen
Ctrl-M	Accept/evaluate the line
Ctrl-N	Retrieve next command from history
Ctrl-P	Retrieve previous command from history
Ctrl-R	Reverse-search command history
Ctrl-S	Forward-search command history
Ctrl-T	Transpose characters
Ctrl-U	Perform Unix line-discard
Ctrl-W	Perform Unix word-rubout
Ctrl-Y	Yank
Ctrl-Z	Suspend (job control works in linux)
Ctrl-H	Backward-delete a character
Ctrl-I	Complete, same as Tab
Meta-B	Go backward one word
Meta-C	Capitalize word
Meta-D	Kill word
Meta-F	Go forward one word
Meta-L	Change word to lowercase
Meta-U	Change word to uppercase
Meta-Y	Yank-pop
Meta-Backspace	Backward-kill word
Meta-<	Retrieve the first command in command history
Meta->	Retrieve the last command in command history

Use

Typically users invoke the shell with the `mongo` (page 908) command at the system prompt. Consider the following examples for other scenarios.

To connect to a database on a remote host using authentication and a non-standard port, use the following form:

```
mongo --username <user> --password <pass> --hostname <host> --port 28015
```

Alternatively, consider the following short form:

```
mongo -u <user> -p <pass> --host <host> --port 28015
```

Replace `<user>`, `<pass>`, and `<host>` with the appropriate values for your situation and substitute or omit the *`--port`* (page 908) as needed.

To execute a JavaScript file without evaluating the `~/.mongorc.js` file before starting a shell session, use the following form:

```
mongo --shell --norc alternate-environment.js
```

To print return a query as *JSON*, from the system prompt using the *--eval* (page 909) option, use the following form:

```
mongo --eval 'db.collection.find().forEach(printjson)'
```

Use single quotes (e.g. `'`) to enclose the JavaScript, as well as the additional JavaScript required to generate this output.

62.1.2 Windows Services

The `mongod.exe` (page 912) and `mongos.exe` (page 913) describe the options available for configuring MongoDB when running as a Windows Service. The `mongod.exe` (page 912) and `mongos.exe` (page 913) binaries provide a superset of the `mongod` (page 897) and `mongos` (page 905) options.

mongod.exe

Synopsis

`mongod.exe` (page 912) is the build of the MongoDB daemon (i.e. `mongod` (page 897)) for the Windows platform. `mongod.exe` (page 912) has all of the features of `mongod` (page 897) on Unix-like platforms and is completely compatible with the other builds of `mongod` (page 897). In addition, `mongod.exe` (page 912) provides several options for interacting with the Windows platform itself.

This document only references options that are unique to `mongod.exe` (page 912). All `mongod` (page 897) options are available. See the "*mongod* (page 897)" and the "*Configuration File Options* (page 944)" documents for more information regarding `mongod.exe` (page 912).

To install and use `mongod.exe` (page 912), read the "*Install MongoDB on Windows* (page 16)" document.

Options

`mongod.exe`

--install
Installs `mongod.exe` (page 912) as a Windows Service and exits.

--remove
Removes the `mongod.exe` (page 912) Windows Service. If `mongod.exe` (page 912) is running, this operation will stop and then remove the service.

Note: *--remove* (page 912) requires the *--serviceName* (page 912) if you configured a non-default *--serviceName* (page 912) during the *--install* (page 912) operation.

--reinstall
Removes `mongod.exe` (page 912) and reinstalls `mongod.exe` (page 912) as a Windows Service.

--serviceName <name>
Default: "MongoDB"

Set the service name of mongod.exe (page 912) when running as a Windows Service. Use this name with the net start <name> and net stop <name> operations.

You must use --serviceName (page 912) in conjunction with either the --install (page 912) or --remove (page 912) install option.

--serviceDisplayName <name>
Default: "Mongo DB"

Sets the name listed for MongoDB on the Services administrative application.

--serviceDescription <description>
Default: "MongoDB Server"

Sets the mongod.exe (page 912) service description.

You must use --serviceDescription (page 913) in conjunction with the --install (page 912) option.

Note: For descriptions that contain spaces, you must enclose the description in quotes.

--serviceUser <user>
Runs the mongod.exe (page 912) service in the context of a certain user. This user must have "Log on as a service" privileges.

You must use --serviceUser (page 913) in conjunction with the --install (page 912) option.

--servicePassword <password>
Sets the password for <user> for mongod.exe (page 912) when running with the --serviceUser (page 913) option.

You must use --servicePassword (page 913) in conjunction with the --install (page 912) option.

mongos.exe

Synopsis

mongos.exe (page 913) is the build of the MongoDB Shard (i.e. mongos (page 905)) for the Windows platform. mongos.exe (page 913) has all of the features of mongos (page 905) on Unix-like platforms and is completely compatible with the other builds of mongos (page 905). In addition, mongos.exe (page 913) provides several options for interacting with the Windows platform itself.

This document only references options that are unique to mongos.exe (page 913). All mongos (page 905) options are available. See the "*mongos* (page 904)" and the "*Configuration File Options* (page 944)" documents for more information regarding mongos.exe (page 913).

To install and use mongos.exe (page 913), read the "*Install MongoDB on Windows* (page 16)" document.

Options

mongos.**exe**

--install
Installs mongos.exe (page 913) as a Windows Service and exits.

--remove
Removes the mongos.exe (page 913) Windows Service. If mongos.exe (page 913) is running, this operation will stop and then remove the service.

Note: *--remove* (page 913) requires the *--serviceName* (page 914) if you configured a non-default *--serviceName* (page 914) during the *--install* (page 913) operation.

--reinstall
Removes mongos.exe (page 913) and reinstalls mongos.exe (page 913) as a Windows Service.

--serviceName <name>
Default: "MongoS"

Set the service name of mongos.exe (page 913) when running as a Windows Service. Use this name with the net start <name> and net stop <name> operations.

You must use *--serviceName* (page 914) in conjunction with either the *--install* (page 913) or *--remove* (page 913) install option.

--serviceDisplayName <name>
Default: "Mongo DB Router"

Sets the name listed for MongoDB on the Services administrative application.

--serviceDescription <description>
Default: "Mongo DB Sharding Router"

Sets the mongos.exe (page 913) service description.

You must use *--serviceDescription* (page 914) in conjunction with the *--install* (page 913) option.

Note: For descriptions that contain spaces, you must enclose the description in quotes.

--serviceUser <user>
Runs the mongos.exe (page 913) service in the context of a certain user. This user must have "Log on as a service" privileges.

You must use *--serviceUser* (page 914) in conjunction with the *--install* (page 913) option.

--servicePassword <password>
Sets the password for <user> for mongos.exe (page 913) when running with the *--serviceUser* (page 914) option.

You must use *--servicePassword* (page 914) in conjunction with the *--install* (page 913) option.

62.1.3 Binary Import and Export Tools

mongodump (page 915) provides a method for creating *BSON* dump files from the mongod (page 897) instances, while mongorestore (page 918) makes it possible to restore these dumps. bsondump (page 921) converts BSON dump files into *JSON*. The mongooplog (page 922) utility provides the ability to stream *oplog* entries outside of normal replication.

mongodump

Synopsis

mongodump (page 915) is a utility for creating a binary export of the contents of a database. Consider using this utility as part an effective *backup strategy* (page 67). Use mongodump (page 915) in conjunction with mongorestore (page 918) to restore databases.

mongodump (page 915) can read data from either *mongod* or mongos (page 905) instances, in addition to reading directly from MongoDB data files without an active mongod (page 897).

Note: The format of data created by mongodump (page 915) tool from the 2.2 distribution or later is different and incompatible with earlier versions of mongod (page 897).

See Also:

mongorestore (page 918), *Create Backup of a Sharded Cluster with Database Dumps* (page 405) and *Backup Strategies for MongoDB Systems* (page 67).

Options

mongodump

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the `-v` form by including the option multiple times, (e.g. `-vvvvv`.)

--version
Returns the version of the mongodump (page 915) utility and exits.

--host <hostname><:port>
Specifies a resolvable hostname for the mongod (page 897) that you wish to use to create the database dump. By default mongodump (page 915) will attempt to connect to a MongoDB process ruining on the localhost port number `27017`.

Optionally, specify a port number to connect a MongoDB instance running on a port other than `27017`.

To connect to a replica set, use the *--host* (page 915) argument with a setname, followed by a slash and a comma-separated list of host names and port numbers. The mongodump (page 915) utility will, given the seed of at least one connected set member, connect to the primary member of that set. This option would resemble:

```
mongodump --host repl0/mongo0.example.net,mongo0.example.net:27018,mongo1.example.net,mongo2.exa
```

You can always connect directly to a single MongoDB instance by specifying the host and port number directly.

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port. (i.e. `27017`) You may also specify a port number using the *--host* (page 915) option.

--ipv6
Enables IPv6 support that allows mongodump (page 915) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongodump (page 915), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *--password* (page 915) option to supply a password.

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *--username* (page 915) option to supply a username.

If you specify a *--username* (page 915) without the *--password* (page 915) option, mongodump (page 915) will prompt for a password interactively.

--dbpath <path>
Specifies the directory of the MongoDB data files. If used, the *--dbpath* (page 915) option enables mongodump (page 915) to attach directly to local data files and copy the data without the mongod (page 897). To run with *--dbpath* (page 915), mongodump (page 915) needs to restrict access to the data directory: as a result, no mongod (page 897) can access the same path while the process runs.

--directoryperdb
Use the *--directoryperdb* (page 916) in conjunction with the corresponding option to mongod (page 897). This option allows mongodump (page 915) to read data files organized with each database located in a distinct directory. This option is only relevant when specifying the *--dbpath* (page 915) option.

--journal
Allows mongodump (page 915) operations to use the durability *journal* to ensure that the export is in a consistent state. This option is only relevant when specifying the *--dbpath* (page 915) option.

--db <db>, **-d** <db>
Use the *--db* (page 916) option to specify a database for mongodump (page 915) to backup. If you do not specify a DB, mongodump (page 915) copies all databases in this instance into the dump files. Use this option to backup or copy a smaller subset of your data.

--collection <collection>, **-c** <collection>
Use the *--collection* (page 916) option to specify a collection for mongodump (page 915) to backup. If you do not specify a collection, this option copies all collections in the specified database or instance to the dump files. Use this option to backup or copy a smaller subset of your data.

--out <path>, **-o** <path>
Specifies a directory where mongodump (page 915) will save the output of the database dump. To output the database dump to standard output, specify a - rather than a path. By default, mongodump (page 915) will save output files in a directory named dump in the current working directory.

--query <json>, **-q** <json>
Provides a query to limit (optionally) the documents included in the output of mongodump (page 915).

--oplog
Use this option to ensure that mongodump (page 915) creates a dump of the database that includes an *oplog*, to create a point-in-time snapshot of the state of a mongod (page 897) instance. To restore to a specific point-in-time backup, use the output created with this option in conjunction with *mongorestore --oplogReplay* (page 919).

Without *--oplog* (page 916), if there are write operations during the dump operation, the dump will not reflect a single moment in time. Changes made to the database during the update process can affect the output of the backup.

--oplog (page 916) has no effect when running mongodump (page 915) against a mongos (page 905) instance to dump the entire contents of a sharded cluster. However, you can use *--oplog* (page 916) to dump individual shards.

Note: *--oplog* (page 916) only works against nodes that maintain a *oplog*. This includes all members of a replica set, as well as *master* nodes in master/slave replication deployments.

--repair
Use this option to run a repair option in addition to dumping the database. The repair option attempts to repair a database that may be in an inconsistent state as a result of an improper shutdown or mongod (page 897) crash.

--forceTableScan
Forces mongodump (page 915) to scan the data store directly: typically, mongodump (page 915) saves entries as they appear in the index of the _id field. Use *--forceTableScan* (page 916) to skip the index and scan the data directly. Typically there are two cases where this behavior is preferable to the default:

1. If you have key sizes over 800 bytes that would not be present in the `_id` index.
2. Your database uses a custom `_id` field.

When you run with *`--forceTableScan`* (page 916), `mongodump` (page 915) does not use `$snapshot` (page 717). As a result, the dump produced by `mongodump` (page 915) can reflect the state of the database at many different points in time.

Warning: Use *`--forceTableScan`* (page 916) with extreme caution and consideration.

Warning: Changed in version 2.2: When used in combination with `fsync` (page 763) or `db.fsyncLock()` (page 848), `mongod` (page 897) may block some reads, including those from `mongodump` (page 915), when queued write operation waits behind the `fsync` (page 763) lock.

Behavior

When running `mongodump` (page 915) against a `mongos` (page 905) instance where the *sharded cluster* consists of *replica sets*, the *read preference* of the operation will prefer reads from *secondary* members of the set.

Usage

See the *Use mongodump and mongorestore to Backup and Restore MongoDB Databases* (page 609) for a larger overview of `mongodump` (page 915) usage. Also see the "*mongorestore* (page 917)" document for an overview of the `mongorestore` (page 918), which provides the related inverse functionality.

The following command, creates a dump file that contains only the collection named `collection` in the database named `test`. In this case the database is running on the local interface on port `27017`:

```
mongodump --collection collection --db test
```

In the next example, `mongodump` (page 915) creates a backup of the database instance stored in the `http://docs.mongodb.org/v2.2/srv/mongodb` directory on the local machine. This requires that no `mongod` (page 897) instance is using the `http://docs.mongodb.org/v2.2/srv/mongodb` directory.

```
mongodump --dbpath /srv/mongodb
```

In the final example, `mongodump` (page 915) creates a database dump located at `http://docs.mongodb.org/v2.2/opt/backup/mongodump-2011-10-24`, from a database running on port `37017` on the host `mongodb1.example.net` and authenticating using the username `user` and the password `pass`, as follows:

```
mongodump --host mongodb1.example.net --port 37017 --username user --password pass /opt/backup/mongod
```

mongorestore

Synopsis

The `mongorestore` (page 918) program writes data from a binary database dump created by `mongodump` (page 915) to a MongoDB instance. `mongorestore` (page 918) can create a new database or add data to an existing database.

`mongorestore` (page 918) can write data to either *mongod* or `mongos` (page 905) instances, in addition to writing directly to MongoDB data files without an active `mongod` (page 897).

If you restore to an existing database, mongorestore (page 918) will only insert into the existing database, and does not perform updates of any kind. If existing documents have the same value _id field in the target database and collection, mongorestore (page 918) will *not* overwrite those documents.

Remember the following properties of mongorestore (page 918) behavior:

- mongorestore (page 918) recreates indexes recorded by mongodump (page 915).
- all operations are inserts, not updates.
- mongorestore (page 918) does not wait for a response from a mongod (page 897) to ensure that the MongoDB process has received or recorded the operation.

  The mongod (page 897) will record any errors to its log that occur during a restore operation, but mongorestore (page 918) will not receive errors.

Note: The format of data created by mongodump (page 915) tool from the 2.2 distribution or later is different and incompatible with earlier versions of mongod (page 897).

Options

mongorestore

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the -v form by including the option multiple times (e.g. -vvvvv).

--version
Returns the version of the mongorestore (page 918) tool.

--host <hostname><:port>
Specifies a resolvable hostname for the mongod (page 897) to which you want to restore the database. By default mongorestore (page 918) will attempt to connect to a MongoDB process running on the localhost port number 27017. For an example of *--host* (page 918), see *Restore a Database with mongorestore* (page 611).

Optionally, specify a port number to connect a MongoDB instance running on a port other than 27017.

To connect to a replica set, you can specify the replica set seed name, and a seed list of set members, in the following format:

```
<replica_set_name>/<hostname1><:port>,<hostname2:<port>,...
```

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port (i.e. 27017). You may also specify a port number using the *--host* (page 918) command. For an example of *--port* (page 918), see *Restore a Database with mongorestore* (page 611).

--ipv6
Enables IPv6 support that allows mongorestore (page 918) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongorestore (page 918), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in

conjunction with the *--password* (page 919) option to supply a password. For an example of *--username* (page 918), see *Restore a Database with mongorestore* (page 611).

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *--username* (page 918) option to supply a username. For an example of *--password* (page 919), see *Restore a Database with mongorestore* (page 611).

If you specify a *--username* (page 918) without the *--password* (page 919) option, mongorestore (page 918) will prompt for a password interactively.

--dbpath <path>
Specifies the directory of the MongoDB data files. If used, the *--dbpath* (page 919) option enables mongorestore (page 918) to attach directly to local data files and insert the data without the mongod (page 897). To run with *--dbpath* (page 919), mongorestore (page 918) needs to lock access to the data directory: as a result, no mongod (page 897) can access the same path while the process runs. For an example of *--dbpath* (page 919), see *Restore without a Running mongod* (page 612).

--directoryperdb
Use the *--directoryperdb* (page 919) in conjunction with the corresponding option to mongod (page 897), which allows mongorestore (page 918) to import data into MongoDB instances that have every database's files saved in discrete directories on the disk. This option is only relevant when specifying the *--dbpath* (page 919) option.

--journal
Allows mongorestore (page 918) write to the durability *journal* to ensure that the data files will remain in a consistent state during the write process. This option is only relevant when specifying the *--dbpath* (page 919) option. For an example of *--journal* (page 919), see *Restore without a Running mongod* (page 612).

--db <db>, **-d** <db>
Use the *--db* (page 919) option to specify a database for mongorestore (page 918) to restore data *into*. If the database doesn't exist, mongorestore (page 918) will create the specified database. If you do not specify a <db>, mongorestore (page 918) creates new databases that correspond to the databases where data originated and data may be overwritten. Use this option to restore data into a MongoDB instance that already has data.

--db (page 919) does *not* control which *BSON* files mongorestore (page 918) restores. You must use the mongorestore (page 918) *path option* (page 920) to limit that restored data.

--collection <collection>, **-c** <collection>
Use the *--collection* (page 919) option to specify a collection for mongorestore (page 918) to restore. If you do not specify a <collection>, mongorestore (page 918) imports all collections created. Existing data may be overwritten. Use this option to restore data into a MongoDB instance that already has data, or to restore only some data in the specified imported data set.

--objcheck
Verifies each object as a valid *BSON* object before inserting it into the target database. If the object is not a valid *BSON* object, mongorestore (page 918) will not insert the object into the target database and stop processing remaining documents for import. This option has some performance impact.

--filter '<JSON>'
Limits the documents that mongorestore (page 918) imports to only those documents that match the JSON document specified as '<JSON>'. Be sure to include the document in single quotes to avoid interaction with your system's shell environment. For an example of *--filter* (page 919), see *Restore a Subset of data from a Binary Database Dump* (page 611).

--drop
Modifies the restoration procedure to drop every collection from the target database before restoring the collection from the dumped backup.

--oplogReplay
Replays the *oplog* after restoring the dump to ensure that the current state of the database reflects the point-in-time backup captured with the "*mongodump --oplog* (page 916)" command. For an example of *--oplogReplay* (page 919), see *Restore Point in Time Oplog Backup* (page 611).

--keepIndexVersion
Prevents mongorestore (page 918) from upgrading the index to the latest version during the restoration process.

--w <number of replicas per write>
New in version 2.2. Specifies the *write concern* for each write operation that mongorestore (page 918) writes to the target database. By default, mongorestore (page 918) does not wait for a response for *write acknowledgment* (page 124).

--noOptionsRestore
New in version 2.2. Prevents mongorestore (page 918) from setting the collection options, such as those specified by the collMod (page 744) *database command*, on restored collections.

--noIndexRestore
New in version 2.2. Prevents mongorestore (page 918) from restoring and building indexes as specified in the corresponding mongodump (page 915) output.

--oplogLimit <timestamp>
New in version 2.2. Prevents mongorestore (page 918) from applying *oplog* entries newer than the <timestamp>. Specify <timestamp> values in the form of <time_t>:<ordinal>, where <time_t> is the seconds since the UNIX epoch, and <ordinal> represents a counter of operations in the oplog that occurred in the specified second.

You must use *--oplogLimit* (page 920) in conjunction with the *--oplogReplay* (page 919) option.

<path>
The final argument of the mongorestore (page 918) command is a directory path. This argument specifies the location of the database dump from which to restore.

Usage

See *Use mongodump and mongorestore to Backup and Restore MongoDB Databases* (page 609) for a larger overview of mongorestore (page 918) usage. Also see the "*mongodump* (page 914)" document for an overview of the mongodump (page 915), which provides the related inverse functionality.

Consider the following example:

```
mongorestore --collection people --db accounts dump/accounts/
```

Here, mongorestore (page 918) reads the database dump in the dump/ sub-directory of the current directory, and restores *only* the documents in the collection named people from the database named accounts. mongorestore (page 918) restores data to the instance running on the localhost interface on port 27017.

In the next example, mongorestore (page 918) restores a backup of the database instance located in dump to a database instance stored in the http://docs.mongodb.org/v2.2/srv/mongodb on the local machine. This requires that there are no active mongod (page 897) instances attached to http://docs.mongodb.org/v2.2/srv/mongodb data directory.

```
mongorestore --dbpath /srv/mongodb
```

In the final example, mongorestore (page 918) restores a database dump located at http://docs.mongodb.org/v2.2/opt/backup/mongodump-2011-10-24, from a database running on port 37017 on the host mongodb1.example.net. mongorestore (page 918) authenticates to the this MongoDB instance using the username user and the password pass, as follows:

```
mongorestore --host mongodb1.example.net --port 37017 --username user --password pass /opt/backup/mor
```

bsondump

Synopsis

The bsondump (page 921) converts *BSON* files into human-readable formats, including *JSON*. For example, bsondump (page 921) is useful for reading the output files generated by mongodump (page 915).

Important: bsondump (page 921) is a diagnostic tool for inspecting BSON files, not a tool for data ingestion or other application use.

Options

bsondump

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the -v form by including the option multiple times, (e.g. -vvvvv.)

--version
Returns the version of the bsondump (page 921) utility.

--objcheck
Validates each *BSON* object before outputting it in *JSON* format. Use this option to filter corrupt objects from the output. This option has some performance impact.

--filter '<JSON>'
Limits the documents that bsondump (page 921) exports to only those documents that match the *JSON document* specified as '<JSON>'. Be sure to include the document in single quotes to avoid interaction with your system's shell environment.

--type <=json|=debug>
Changes the operation of bsondump (page 921) from outputting "*JSON*" (the default) to a debugging format.

<bsonfilename>
The final argument to bsondump (page 921) is a document containing *BSON*. This data is typically generated by mongodump (page 915) or by MongoDB in a *rollback* operation.

Usage

By default, bsondump (page 921) outputs data to standard output. To create corresponding *JSON* files, you will need to use the shell redirect. See the following command:

```
bsondump collection.bson > collection.json
```

Use the following command (at the system shell) to produce debugging output for a *BSON* file:

```
bsondump --type=debug collection.bson
```

mongooplog

New in version 2.2.

Synopsis

mongooplog (page 922) is a simple tool that polls operations from the *replication oplog* of a remote server, and applies them to the local server. This capability supports certain classes of real-time migrations that require that the source server remain online and in operation throughout the migration process.

Typically this command will take the following form:

```
mongooplog  --from mongodb0.example.net --host mongodb1.example.net
```

This command copies oplog entries from the mongod (page 897) instance running on the host mongodb0.example.net and duplicates operations to the host mongodb1.example.net. If you do not need to keep the *--from* (page 923) host running during the migration, consider using mongodump (page 915) and mongorestore (page 918) or another *backup* (page 67) operation, which may be better suited to your operation.

Note: If the mongod (page 897) instance specified by the *--from* (page 923) argument is running with authentication (page 947), then mongooplog (page 922) will not be able to copy oplog entries.

See Also:

mongodump (page 915), mongorestore (page 918), "*Backup Strategies for MongoDB Systems* (page 67)", "*Oplog Internals Overview* (page 312)", and "*Replica Set Oplog Sizing* (page 282)".

Options

mongooplog

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the -v form by including the option multiple times, (e.g. -vvvvv.)

--version
Returns the version of the mongooplog (page 922) utility.

--host <hostname><:port>, **-h**
Specifies a resolvable hostname for the mongod (page 897) instance to which mongooplog (page 922) will apply *oplog* operations retrieved from the serve specified by the *--from* (page 923) option.

mongooplog (page 922) assumes that all target mongod (page 897) instances are accessible by way of port 27017. You may, optionally, declare an alternate port number as part of the hostname argument.

You can always connect directly to a single mongod (page 897) instance by specifying the host and port number directly.

To connect to a replica set, you can specify the replica set seed name, and a seed list of set members, in the following format:

```
<replica_set_name>/<hostname1><:port>,<hostname2:<port>,...
```

--port
Specifies the port number of the mongod (page 897) instance where mongooplog (page 922) will apply *oplog* entries. Only specify this option if the MongoDB instance that you wish to connect to is not running on the standard port. (i.e. 27017) You may also specify a port number using the *--host* (page 922) command.

--ipv6
Enables IPv6 support that allows mongooplog (page 922) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongooplog (page 922), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *--password* (page 923) option to supply a password.

--password <password>, **-p** <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *--username* (page 923) option to supply a username.

If you specify a *--username* (page 923) without the *--password* (page 923) option, mongooplog (page 922) will prompt for a password interactively.

--dbpath <path>
Specifies a directory, containing MongoDB data files, to which mongooplog (page 922) will apply operations from the *oplog* of the database specified with the *--from* (page 923) option. When used, the *--dbpath* (page 923) option enables mongo (page 908) to attach directly to local data files and write data without a running mongod (page 897) instance. To run with *--dbpath* (page 923), mongooplog (page 922) needs to restrict access to the data directory: as a result, no mongod (page 897) can be access the same path while the process runs.

--directoryperdb
Use the *--directoryperdb* (page 923) in conjunction with the corresponding option to mongod (page 897). This option allows mongooplog (page 922) to write to data files organized with each database located in a distinct directory. This option is only relevant when specifying the *--dbpath* (page 923) option.

--journal
Allows mongooplog (page 922) operations to use the durability *journal* to ensure that the data files will remain in a consistent state during the writing process. This option is only relevant when specifying the *--dbpath* (page 923) option.

--fields [field1[,field2]], **-f** [field1[,field2]]
Specify a field or number fields to constrain which data mongooplog (page 922) will migrate. All other fields will be *excluded* from the migration. Comma separate a list of fields to limit the applied fields.

--fieldFile <file>
As an alternative to "*--fields* (page 923)" the *--fieldFile* (page 923) option allows you to specify a file (e.g. <file>) that holds a list of field names to *include* in the migration. All other fields will be *excluded* from the migration. Place one field per line.

--seconds <number>, **-s** <number>
Specify a number of seconds of operations for mongooplog (page 922) to pull from the *remote host* (page 923). Unless specified the default value is 86400 seconds, or 24 hours.

--from <host[:port]>
Specify the host for mongooplog (page 922) to retrieve *oplog* operations from. mongooplog (page 922) *requires* this option.

Unless you specify the *--host* (page 922) option, mongooplog (page 922) will apply the operations collected with this option to the oplog of the mongod (page 897) instance running on the localhost interface connected to port 27017.

--ologns <namespace>
Specify a namespace in the *--from* (page 923) host where the oplog resides. The default value is `local.oplog.rs`, which is the where *replica set* members store their operation log. However, if you've copied *oplog* entries into another database or collection, use this option to copy oplog entries stored in another location.

Namespaces take the form of `[database].[collection]`.

Usage Consider the following prototype `mongooplog` (page 922) command:

```
mongooplog --from mongodb0.example.net --host mongodb1.example.net
```

Here, entries from the *oplog* of the `mongod` (page 897) running on port `27017`. This only pull entries from the last 24 hours.

In the next command, the parameters limit this operation to only apply operations to the database `people` in the collection `usage` on the target host (i.e. `mongodb1.example.net`):

```
mongooplog --from mongodb0.example.net --host mongodb1.example.net --database people --collection us
```

This operation only applies oplog entries from the last 24 hours. Use the *--seconds* (page 923) argument to capture a greater or smaller amount of time. Consider the following example:

```
mongooplog --from mongodb0.example.net --seconds 172800
```

In this operation, `mongooplog` (page 922) captures 2 full days of operations. To migrate 12 hours of *oplog* entries, use the following form:

```
mongooplog --from mongodb0.example.net --seconds 43200
```

For the previous two examples, `mongooplog` (page 922) migrates entries to the `mongod` (page 897) process running on the localhost interface connected to the `27017` port. `mongooplog` (page 922) can also operate directly on MongoDB's data files if no `mongod` (page 897) is running on the *target* host. Consider the following example:

```
mongooplog --from mongodb0.example.net --dbpath /srv/mongodb --journal
```

Here, `mongooplog` (page 922) imports *oplog* operations from the `mongod` (page 897) host connected to port `27017`. This migrates operations to the MongoDB data files stored in the `http://docs.mongodb.org/v2.2/srv/mongodb` directory. Additionally `mongooplog` (page 922) will use the durability *journal* to ensure that the data files remain in a consistent state.

62.1.4 Data Import and Export Tools

`mongoimport` (page 925) provides a method for taking data in *JSON*, *CSV*, or *TSV* and importing it into a `mongod` (page 897) instance. `mongoexport` (page 928) provides a method to export data from a `mongod` (page 897) instance into JSON, CSV, or TSV.

Note: The conversion between BSON and other formats lacks full type fidelity. Therefore you cannot use `mongoimport` (page 925) and `mongoexport` (page 928) for round-trip import and export operations.

---

mongoimport

Synopsis

The mongoimport (page 925) tool provides a route to import content from a JSON, CSV, or TSV export created by mongoexport (page 928), or potentially, another third-party export tool. See the "*Importing and Exporting MongoDB Data* (page 63)" document for a more in depth usage overview, and the "*mongoexport* (page 928)" document for more information regarding mongoexport (page 928), which provides the inverse "importing" capability.

Note: Do not use mongoimport (page 925) and mongoexport (page 928) for full instance, production backups because they will not reliably capture data type information. Use mongodump (page 915) and mongorestore (page 918) as described in "*Backup Strategies for MongoDB Systems* (page 67)" for this kind of functionality.

Options

mongoimport

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the `-v` form by including the option multiple times, (e.g. `-vvvvv`.)

--version
Returns the version of the mongoimport (page 925) program.

--host <hostname><:port>, **-h**
Specifies a resolvable hostname for the mongod (page 897) to which you want to restore the database. By default mongoimport (page 925) will attempt to connect to a MongoDB process ruining on the localhost port numbered 27017.

Optionally, specify a port number to connect a MongoDB instance running on a port other than 27017.

To connect to a replica set, use the *--host* (page 925) argument with a setname, followed by a slash and a comma-separated list of host and port names. mongoimport (page 925) will, given the seed of at least one connected set member, connect to primary node of that set. This option would resemble:

```
--host repl0/mongo0.example.net,mongo0.example.net:27018,mongo1.example.net,mongo2.example.net
```

You can always connect directly to a single MongoDB instance by specifying the host and port number directly.

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port. (i.e. 27017) You may also specify a port number using the *mongoimport --host* (page 925) command.

--ipv6
Enables IPv6 support that allows mongoimport (page 925) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongoimport (page 925), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *mongoimport --password* (page 925) option to supply a password.

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *mongoimport --username* (page 925) option to supply a username.

If you specify a *--username* (page 925) without the *--password* (page 925) option, mongoimport (page 925) will prompt for a password interactively.

--dbpath <path>
Specifies the directory of the MongoDB data files. If used, the *--dbpath* (page 926) option enables mongoimport (page 925) to attach directly to local data files and insert the data without the mongod (page 897). To run with --dbpath, mongoimport (page 925) needs to lock access to the data directory: as a result, no mongod (page 897) can access the same path while the process runs.

--directoryperdb
Use the *--directoryperdb* (page 926) in conjunction with the corresponding option to mongod (page 897), which allows mongoimport (page 925) to import data into MongoDB instances that have every database's files saved in discrete directories on the disk. This option is only relevant when specifying the *--dbpath* (page 926) option.

--journal
Allows mongoexport (page 928) write to the durability *journal* to ensure that the data files will remain in a consistent state during the write process. This option is only relevant when specifying the *--dbpath* (page 926) option.

--db <db>, **-d** <db>
Use the *--db* (page 926) option to specify a database for mongoimport (page 925) to restore data. If you do not specify a <db>, mongoimport (page 925) creates new databases that correspond to the databases where data originated and data may be overwritten. Use this option to restore data into a MongoDB instance that already has data, or to restore only some data in the specified backup.

--collection <collection>, **-c** <collection>
Use the *--collection* (page 926) option to specify a collection for mongorestore (page 918) to restore. If you do not specify a <collection>, mongoimport (page 925) imports all collections created. Existing data may be overwritten. Use this option to restore data into a MongoDB instance that already has data, or to restore only some data in the specified imported data set.

--fields <field1<,filed2>>, **-f** <field1[,filed2]>
Specify a comma separated list of field names when importing *csv* or *tsv* files that do not have field names in the first (i.e. header) line of the file.

--fieldFile <filename>
As an alternative to "*--fields* (page 926)" the *--fieldFile* (page 926) option allows you to specify a file (e.g. <file> ') to that holds a list of field names if your *csv* or *tsv* file does not include field names in the first (i.e. header) line of the file. Place one field per line.

--ignoreBlanks
In *csv* and *tsv* exports, ignore empty fields. If not specified, mongoimport (page 925) creates fields without values in imported documents.

--type <json|csv|tsv>
Declare the type of export format to import. The default format is *JSON*, but it's possible to import *csv* and *tsv* files.

--file <filename>
Specify the location of a file containing the data to import. mongoimport (page 925) will read data from standard input (e.g. "stdin.") if you do not specify a file.

--drop
Modifies the importation procedure so that the target instance drops every collection before restoring the collection from the dumped backup.

--headerline
If using "*--type csv* (page 926)" or "*--type tsv* (page 926)," use the first line as field names. Otherwise, mongoimport (page 925) will import the first line as a distinct document.

--upsert
Modifies the import process to update existing objects in the database if they match an imported object, while inserting all other objects.

If you do not specify a field or fields using the *--upsertFields* (page 927) mongoimport (page 925) will upsert on the basis of the _id field.

--upsertFields <field1[,field2]>
Specifies a list of fields for the query portion of the *upsert*. Use this option if the _id fields in the existing documents don't match the field in the document, but another field or field combination can uniquely identify documents as a basis for performing upsert operations.

To ensure adequate performance, indexes should exist for this field or fields.

--stopOnError
New in version 2.2. Forces mongoimport (page 925) to halt the import operation at the first error rather than continuing the operation despite errors.

--jsonArray
Changed in version 2.2: The limit on document size increased from 4MB to 16MB. Accept import of data expressed with multiple MongoDB document within a single *JSON* array.

Use in conjunction with *mongoexport --jsonArray* (page 929) to import data written as a single *JSON* array. Limited to imports of 16 MB or smaller.

Usage

In this example, mongoimport (page 925) imports the *csv* formatted data in the http://docs.mongodb.org/v2.2/opt/backups/contacts.csv into the collection contacts in the users database on the MongoDB instance running on the localhost port numbered 27017.

```
mongoimport --db users --collection contacts --type csv --file /opt/backups/contacts.csv
```

In the following example, mongoimport (page 925) imports the data in the *JSON* formatted file contacts.json into the collection contacts on the MongoDB instance running on the localhost port number 27017. Journaling is explicitly enabled.

```
mongoimport --collection contacts --file contacts.json --journal
```

In the next example, mongoimport (page 925) takes data passed to it on standard input (i.e. with a | pipe.) and imports it into the collection contacts in the sales database is the MongoDB datafiles located at http://docs.mongodb.org/v2.2/srv/mongodb/. if the import process encounters an error, the mongoimport (page 925) will halt because of the *--stopOnError* (page 927) option.

```
mongoimport --db sales --collection contacts --stopOnError --dbpath /srv/mongodb/
```

In the final example, mongoimport (page 925) imports data from the file http://docs.mongodb.org/v2.2/opt/backups/mdb1-examplenet.json into the collection contacts within the database marketing on a remote MongoDB database. This mongoimport (page 925) accesses the mongod (page 897) instance running on the host mongodb1.example.net over port 37017, which requires the username user and the password pass.

```
mongoimport --host mongodb1.example.net --port 37017 --username user --password pass --collection co
```

mongoexport

Synopsis

mongoexport (page 928) is a utility that produces a JSON or CSV export of data stored in a MongoDB instance. See the "*Importing and Exporting MongoDB Data* (page 63)" document for a more in depth usage overview, and the "*mongoimport* (page 925)" document for more information regarding the mongoimport (page 925) utility, which provides the inverse "importing" capability.

Note: Do not use mongoimport (page 925) and mongoexport (page 928) for full-scale backups because they may not reliably capture data type information. Use mongodump (page 915) and mongorestore (page 918) as described in "*Backup Strategies for MongoDB Systems* (page 67)" for this kind of functionality.

Options

mongoexport

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the -v form by including the option multiple times, (e.g. -vvvvv.)

--version
Returns the version of the mongoexport (page 928) utility.

--host <hostname><:port>
Specifies a resolvable hostname for the mongod (page 897) from which you want to export data. By default mongoexport (page 928) attempts to connect to a MongoDB process ruining on the localhost port number 27017.

Optionally, specify a port number to connect a MongoDB instance running on a port other than 27017.

To connect to a replica set, you can specify the replica set seed name, and a seed list of set members, in the following format:

```
<replica_set_name>/<hostname1><:port>,<hostname2:<port>,...
```

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port. (i.e. 27017) You may also specify a port number using the *mongoexport --host* (page 928) command.

--ipv6
Enables IPv6 support that allows mongoexport (page 928) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongoexport (page 928), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *mongoexport --password* (page 928) option to supply a password.

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *--username* (page 928) option to supply a username.

If you specify a *--username* (page 928) without the *--password* (page 928) option, mongoexport (page 928) will prompt for a password interactively.

--dbpath <path>
Specifies the directory of the MongoDB data files. If used, the --dbpath option enables mongoexport (page 928) to attach directly to local data files and insert the data without the mongod (page 897). To run with --dbpath, mongoexport (page 928) needs to lock access to the data directory: as a result, no mongod (page 897) can access the same path while the process runs.

--directoryperdb
Use the *--directoryperdb* (page 929) in conjunction with the corresponding option to mongod (page 897), which allows mongoexport (page 928) to export data into MongoDB instances that have every database's files saved in discrete directories on the disk. This option is only relevant when specifying the *--dbpath* (page 929) option.

--journal
Allows mongoexport (page 928) operations to access the durability *journal* to ensure that the export is in a consistent state. This option is only relevant when specifying the *--dbpath* (page 929) option.

--db <db>, **-d** <db>
Use the *--db* (page 929) option to specify the name of the database that contains the collection you want to export.

--collection <collection>, **-c** <collection>
Use the *--collection* (page 929) option to specify the collection that you want mongoexport (page 928) to export.

--fields <field1[,field2]>, **-f** <field1[,field2]>
Specify a field or fields to *include* in the export. Use a comma separated list of fields to specify multiple fields.

For *--csv* (page 929) output formats, mongoexport (page 928) includes only the specified field(s), and the specified field(s) can be a field within a sub-document.

For *JSON* output formats, mongoexport (page 928) includes only the specified field(s) **and** the _id field, and if the specified field(s) is a field within a sub-document, the mongoexport (page 928) includes the sub-document with all its fields, not just the specified field within the document.

--fieldFile <file>
As an alternative to *--fields* (page 929), the *--fieldFile* (page 929) option allows you to specify in a file the field or fields to *include* in the export and is **only valid** with the *--csv* (page 929) option. The file must have only one field per line, and the line(s) must end with the LF character (0x0A).

mongoexport (page 928) includes only the specified field(s). The specified field(s) can be a field within a sub-document.

--query <JSON>
Provides a *JSON document* as a query that optionally limits the documents returned in the export.

--csv
Changes the export format to a comma separated values (CSV) format. By default mongoexport (page 928) writes data using one *JSON* document for every MongoDB document.

If you specify *--csv* (page 929), then you must also use either the *--fields* (page 929) or the *--fieldFile* (page 929) option to declare the fields to export from the collection.

--jsonArray
Modifies the output of mongoexport (page 928) to write the entire contents of the export as a single *JSON* array. By default mongoexport (page 928) writes data using one JSON document for every MongoDB document.

--slaveOk, -k
Allows mongoexport (page 928) to read data from secondary or slave nodes when using mongoexport (page 928) with a replica set. This option is only available if connected to a mongod (page 897) or mongos (page 905) and is not available when used with the "*mongoexport --dbpath* (page 929)" option.

This is the default behavior.

--out <file>, **-o** <file>
Specify a file to write the export to. If you do not specify a file name, the mongoexport (page 928) writes data to standard output (e.g. stdout).

--forceTableScan
New in version 2.2. Forces mongoexport (page 928) to scan the data store directly: typically, mongoexport (page 928) saves entries as they appear in the index of the _id field. Use *--forceTableScan* (page 930) to skip the index and scan the data directly. Typically there are two cases where this behavior is preferable to the default:

1. If you have key sizes over 800 bytes that would not be present in the _id index.
2. Your database uses a custom _id field.

When you run with *--forceTableScan* (page 930), mongoexport (page 928) does not use $snapshot (page 717). As a result, the export produced by mongoexport (page 928) can reflect the state of the database at many different points in time.

> **Warning:** Use *--forceTableScan* (page 930) with extreme caution and consideration.

Usage

In the following example, mongoexport (page 928) exports the collection contacts from the users database from the mongod (page 897) instance running on the localhost port number 27017. This command writes the export data in *CSV* format into a file located at http://docs.mongodb.org/v2.2/opt/backups/contacts.csv. The fields.txt file contains a line-separated list of fields to export.

```
mongoexport --db users --collection contacts --csv --fieldFile fields.txt --out /opt/backups/contacts
```

The next example creates an export of the collection contacts from the MongoDB instance running on the localhost port number 27017, with journaling explicitly enabled. This writes the export to the contacts.json file in *JSON* format.

```
mongoexport --db sales --collection contacts --out contacts.json --journal
```

The following example exports the collection contacts from the sales database located in the MongoDB data files located at http://docs.mongodb.org/v2.2/srv/mongodb/. This operation writes the export to standard output in *JSON* format.

```
mongoexport --db sales --collection contacts --dbpath /srv/mongodb/
```

> **Warning:** The above example will only succeed if there is no mongod (page 897) connected to the data files located in the http://docs.mongodb.org/v2.2/srv/mongodb/ directory.

The final example exports the collection contacts from the database marketing . This data resides on the MongoDB instance located on the host mongodb1.example.net running on port 37017, which requires the username user and the password pass.

```
mongoexport --host mongodb1.example.net --port 37017 --username user --password pass --collection co
```

62.1.5 Diagnostic Tools

mongostat (page 931), mongotop (page 935), and mongosniff (page 938) provide diagnostic information related to the current operation of a mongod (page 897) instance.

Note: Because mongosniff (page 938) depends on *libpcap*, most distributions of MongoDB do *not* include mongosniff (page 938).

---

mongostat

Synopsis

The mongostat (page 931) utility provides a quick overview of the status of a currently running mongod (page 897) or mongos (page 905) instance. mongostat (page 931) is functionally similar to the UNIX/Linux file system utility vmstat, but provides data regarding mongod (page 897) and mongos (page 905) instances.

See Also:

For more information about monitoring MongoDB, see *Monitoring Database Systems* (page 55).

For more background on various other MongoDB status outputs see:

- *Server Status Reference* (page 965)
- *Replica Set Status Reference* (page 987)
- *Database Statistics Reference* (page 979)
- *Collection Statistics Reference* (page 980)

For an additional utility that provides MongoDB metrics see "*mongotop* (page 935)."

mongostat (page 931) connects to the mongod (page 897) instance running on the local host interface on TCP port 27017; however, mongostat (page 931) can connect to any accessible remote mongod (page 897) instance.

Options

mongostat

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the -v form by including the option multiple times, (e.g. -vvvvv.)

--version
Returns the version of the mongostat (page 931) utility.

--host <hostname><:port>
Specifies a resolvable hostname for the mongod (page 897) from which you want to export data. By default mongostat (page 931) attempts to connect to a MongoDB instance running on the localhost port number 27017.

Optionally, specify a port number to connect a MongoDB instance running on a port other than 27017.

To connect to a replica set, you can specify the replica set seed name, and a seed list of set members, in the following format:

```
<replica_set_name>/<hostname1><:port>,<hostname2:<port>,...
```

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port. (i.e. 27017) You may also specify a port number using the *mongostat --host* (page 931) command.

--ipv6
Enables IPv6 support that allows mongostat (page 931) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongostat (page 931), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *mongostat --password* (page 932) option to supply a password.

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *mongostat --username* (page 932) option to supply a username.

If you specify a *--username* (page 932) without the *--password* (page 932) option, mongostat (page 931) will prompt for a password interactively.

--noheaders
Disables the output of column or field names.

--rowcount <number>, **-n** <number>
Controls the number of rows to output. Use in conjunction with the sleeptime argument to control the duration of a mongostat (page 931) operation.

Unless *--rowcount* (page 932) is specified, mongostat (page 931) will return an infinite number of rows (e.g. value of 0.)

--http
Configures mongostat (page 931) to collect data using the HTTP interface rather than a raw database connection.

--discover
With this option mongostat (page 931) discovers and reports on statistics from all members of a *replica set* or *sharded cluster*. When connected to any member of a replica set, *--discover* (page 932) all non-*hidden members* of the replica set. When connected to a mongos (page 905), mongostat (page 931) will return data from all *shards* in the cluster. If a replica set provides a shard in the sharded cluster, mongostat (page 931) will report on non-hidden members of that replica set.

The *mongostat --host* (page 931) option is not required but potentially useful in this case.

--all
Configures mongostat (page 931) to return all optional *fields* (page 933).

<sleeptime>
The final argument is the length of time, in seconds, that mongostat (page 931) waits in between calls. By default mongostat (page 931) returns one call every second.

mongostat (page 931) returns values that reflect the operations over a 1 second period. For values of <sleeptime> greater than 1, mongostat (page 931) averages data to reflect average operations per second.

Fields

mongostat (page 931) returns values that reflect the operations over a 1 second period. When **mongostat <sleep-time>** has a value greater than 1, mongostat (page 931) averages the statistics to reflect average operations per second.

mongostat (page 931) outputs the following fields:

inserts
The number of objects inserted into the database per second. If followed by an asterisk (e.g. *), the datum refers to a replicated operation.

query
The number of query operations per second.

update
The number of update operations per second.

delete
The number of delete operations per second.

getmore
The number of get more (i.e. cursor batch) operations per second.

command
The number of commands per second. On *slave* and *secondary* systems, mongostat (page 931) presents two values separated by a pipe character (e.g. |), in the form of local|replicated commands.

flushes
The number of *fsync* operations per second.

mapped
The total amount of data mapped in megabytes. This is the total data size at the time of the last mongostat (page 931) call.

size
The amount of (virtual) memory in megabytes used by the process at the time of the last mongostat (page 931) call.

res
The amount of (resident) memory in megabytes used by the process at the time of the last mongostat (page 931) call.

faults
Changed in version 2.1. The number of page faults per second.

Before version 2.1 this value was only provided for MongoDB instances running on Linux hosts.

locked
The percent of time in a global write lock. Changed in version 2.2: The locked db field replaces the locked % field to more appropriate data regarding the database specific locks in version 2.2.

locked db
New in version 2.2. The percent of time in the per-database context-specific lock. mongostat (page 931) will report the database that has spent the most time since the last mongostat (page 931) call with a write lock.

This value represents the amount of time that the listed database spent in a locked state *combined* with the time that the mongod (page 897) spent in the global lock. Because of this, and the sampling method, you may see some values greater than 100%.

idx miss
The percent of index access attempts that required a page fault to load a btree node. This is a sampled value.

qr
The length of the queue of clients waiting to read data from the MongoDB instance.

qw
The length of the queue of clients waiting to write data from the MongoDB instance.

ar
The number of active clients performing read operations.

aw
The number of active clients performing write operations.

netIn
The amount of network traffic, in *bytes*, received by the MongoDB instance.

This includes traffic from `mongostat` (page 931) itself.

netOut
The amount of network traffic, in *bytes*, sent by the MongoDB instance.

This includes traffic from `mongostat` (page 931) itself.

conn
The total number of open connections.

set
The name, if applicable, of the replica set.

repl
The replication status of the node.

Value	Replication Type
M	*master*
SEC	*secondary*
REC	recovering
UNK	unknown
SLV	*slave*

Usage

In the first example, `mongostat` (page 931) will return data every second for 20 seconds. `mongostat` (page 931) collects data from the `mongod` (page 897) instance running on the localhost interface on port 27017. All of the following invocations produce identical behavior:

```
mongostat --rowcount 20 1
mongostat --rowcount 20
mongostat -n 20 1
mongostat -n 20
```

In the next example, `mongostat` (page 931) returns data every 5 minutes (or 300 seconds) for as long as the program runs. `mongostat` (page 931) collects data from the `mongod` (page 897) instance running on the localhost interface on port `27017`. Both of the following invocations produce identical behavior.

```
mongostat --rowcount 0 300
mongostat -n 0 300
mongostat 300
```

In the following example, `mongostat` (page 931) returns data every 5 minutes for an hour (12 times.) `mongostat` (page 931) collects data from the `mongod` (page 897) instance running on the localhost interface on port 27017. Both of the following invocations produce identical behavior.

```
mongostat --rowcount 12 300
mongostat -n 12 300
```

In many cases, using the *--discover* (page 932) will help provide a more complete snapshot of the state of an entire group of machines. If a mongos (page 905) process connected to a *sharded cluster* is running on port 27017 of the local machine, you can use the following form to return statistics from all members of the cluster:

```
mongostat --discover
```

mongotop

Synopsis

mongotop (page 935) provides a method to track the amount of time a MongoDB instance spends reading and writing data. mongotop (page 935) provides statistics on a per-collection level. By default, mongotop (page 935) returns values every second.

See Also:

For more information about monitoring MongoDB, see *Monitoring Database Systems* (page 55).

For additional background on various other MongoDB status outputs see:

- *Server Status Reference* (page 965)
- *Replica Set Status Reference* (page 987)
- *Database Statistics Reference* (page 979)
- *Collection Statistics Reference* (page 980)

For an additional utility that provides MongoDB metrics see "*mongostat* (page 931)."

Options

mongotop

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the -v form by including the option multiple times, (e.g. -vvvvv.)

--version
Print the version of the mongotop (page 935) utility and exit.

--host <hostname><:port>
Specifies a resolvable hostname for the mongod from which you want to export data. By default mongotop (page 935) attempts to connect to a MongoDB process running on the localhost port number 27017.

Optionally, specify a port number to connect a MongoDB instance running on a port other than 27017.

To connect to a replica set, you can specify the replica set seed name, and a seed list of set members, in the following format:

```
<replica_set_name>/<hostname1><:port>,<hostname2:<port>,...
```

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port. (i.e. 27017) You may also specify a port number using the *mongotop --host* (page 935) command.

--ipv6
Enables IPv6 support that allows mongotop (page 935) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongotop (page 935), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *mongotop* (page 936) option to supply a password.

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *--username* (page 936) option to supply a username.

If you specify a *--username* (page 936) without the *--password* (page 936) option, mongotop (page 935) will prompt for a password interactively.

--locks
New in version 2.2. Toggles the mode of mongotop (page 935) to report on use of per-database *locks* (page 966). These data are useful for measuring concurrent operations and lock percentage.

<sleeptime>
The final argument is the length of time, in seconds, that mongotop (page 935) waits in between calls. By default mongotop (page 935) returns data every second.

Fields

mongotop (page 935) returns time values specified in milliseconds (ms.)

mongotop (page 935) only reports active namespaces or databases, depending on the *--locks* (page 936) option. If you don't see a database or collection, it has received no recent activity. You can issue a simple operation in the mongo (page 908) shell to generate activity to affect the output of mongotop (page 935).

mongotop.**ns**
Contains the database namespace, which combines the database name and collection. Changed in version 2.2: If you use the *--locks* (page 936), the ns (page 936) field does not appear in the mongotop (page 935) output.

mongotop.**db**
New in version 2.2. Contains the name of the database. The database named . refers to the global lock, rather than a specific database.

This field does not appear unless you have invoked mongotop (page 935) with the *--locks* (page 936) option.

mongotop.**total**
Provides the total amount of time that this mongod (page 897) spent operating on this namespace.

mongotop.**read**
Provides the amount of time that this mongod (page 897) spent performing read operations on this namespace.

mongotop.**write**
Provides the amount of time that this mongod (page 897) spent performing write operations on this namespace.

mongotop.**<timestamp>**
Provides a time stamp for the returned data.

Use

By default mongotop (page 935) connects to the MongoDB instance running on the localhost port 27017. However, mongotop (page 935) can optionally connect to remote mongod (page 897) instances. See the *mongotop options* (page 935) for more information.

To force mongotop (page 935) to return less frequently specify a number, in seconds at the end of the command. In this example, mongotop (page 935) will return every 15 seconds.

```
mongotop 15
```

This command produces the following output:

```
connected to: 127.0.0.1

                    ns       total        read       write            2012-08-13T15:45:40
test.system.namespaces         0ms         0ms         0ms
  local.system.replset         0ms         0ms         0ms
  local.system.indexes         0ms         0ms         0ms
  admin.system.indexes         0ms         0ms         0ms
                admin.         0ms         0ms         0ms

                    ns       total        read       write            2012-08-13T15:45:55
test.system.namespaces         0ms         0ms         0ms
  local.system.replset         0ms         0ms         0ms
  local.system.indexes         0ms         0ms         0ms
  admin.system.indexes         0ms         0ms         0ms
                admin.         0ms         0ms         0ms
```

To return a mongotop (page 935) report every 5 minutes, use the following command:

```
mongotop 300
```

To report the use of per-database locks, use *mongotop --locks* (page 936), which produces the following output:

```
$ mongotop --locks
connected to: 127.0.0.1

                  db       total        read       write          2012-08-13T16:33:34
               local         0ms         0ms         0ms
               admin         0ms         0ms         0ms
                   .         0ms         0ms         0ms
```

mongosniff

Synopsis

mongosniff (page 938) provides a low-level operation tracing/sniffing view into database activity in real time. Think of mongosniff (page 938) as a MongoDB-specific analogue of tcpdump for TCP/IP network traffic. Typically, mongosniff (page 938) is most frequently used in driver development.

Note: mongosniff (page 938) requires libpcap and is only available for Unix-like systems. Furthermore, the version distributed with the MongoDB binaries is dynamically linked against aversion 0.9 of libpcap. If your system has a different version of libpcap, you will need to compile mongosniff (page 938) yourself or create a symbolic link pointing to libpcap.so.0.9 to your local version of libpcap. Use an operation that resembles the following:

```
ln -s /usr/lib/libpcap.so.1.1.1 /usr/lib/libpcap.so.0.9
```

Change the path's and name of the shared library as needed.

As an alternative to mongosniff (page 938), Wireshark, a popular network sniffing tool is capable of inspecting and parsing the MongoDB wire protocol.

Options

mongosniff

--help
Returns a basic help and usage text.

--forward <host><:port>
Declares a host to forward all parsed requests that the mongosniff (page 938) intercepts to another mongod (page 897) instance and issue those operations on that database instance.

Specify the target host name and port in the <host><:port> format.

To connect to a replica set, you can specify the replica set seed name, and a seed list of set members, in the following format:

```
<replica_set_name>/<hostname1><:port>,<hostname2:<port>,...
```

--source <NET [interface]>, <FILE [filename]>, <DIAGLOG [filename]>
Specifies source material to inspect. Use `--source NET [interface]` to inspect traffic from a network interface (e.g. `eth0` or `lo`.) Use `--source FILE [filename]` to read captured packets in *pcap* format.

You may use the `--source DIAGLOG [filename]` option to read the output files produced by the *--diaglog* (page 899) option.

--objcheck
Modifies the behavior to *only* display invalid BSON objects and nothing else. Use this option for troubleshooting driver development. This option has some performance impact on the performance of mongosniff (page 938).

<port>
Specifies alternate ports to sniff for traffic. By default, mongosniff (page 938) watches for MongoDB traffic on port 27017. Append multiple port numbers to the end of mongosniff (page 938) to monitor traffic on multiple ports.

Usage

Use the following command to connect to a mongod (page 897) or mongos (page 905) running on port 27017 *and* 27018 on the localhost interface:

```
mongosniff --source NET lo 27017 27018
```

Use the following command to only log invalid *BSON* objects for the mongod (page 897) or mongos (page 905) running on the localhost interface and port 27018, for driver development and troubleshooting:

```
mongosniff --objcheck --source NET lo 27018
```

Build mongosniff

To build mongosniff yourself, Linux users can use the following procedure:

1. Obtain prerequisites using your operating systems package management software. Dependencies include:
   - `libpcap` - to capture network packets.
   - `git` - to download the MongoDB source code.
   - `scons` and a C++ compiler - to build `mongosniff` (page 938).
2. Download a copy of the MongoDB source code using `git`:

   ```
   git clone git://github.com/mongodb/mongo.git
   ```

3. Issue the following sequence of commands to change to the `mongo/` directory and build `mongosniff` (page 938):

   ```
   cd mongo
   scons mongosniff
   ```

Note: If you run `scons mongosniff` before installing `libpcap` you must run `scons clean` before you can build `mongosniff` (page 938).

---

mongoperf

Synopsis

`mongoperf` (page 939) is a utility to check disk I/O performance independently of MongoDB.

It times tests of random disk I/O and presents the results. You can use `mongoperf` (page 939) for any case apart from MongoDB. The `mmf` (page 940) `true` mode is completely generic. In that mode is it somewhat analogous to tools such as bonnie++ (albeit mongoperf is simpler).

Specify options to `mongoperf` (page 939) using a JavaScript document.

See Also:

- bonnie
- bonnie++
- Output from an example run
- Checking Disk Performance with the mongoperf Utility

Options

mongoperf

--help
Displays the options to `mongoperf` (page 939). Specify options to `mongoperf` (page 939) with a JSON document described in the *Configuration Fields* (page 940) section.

<jsonconfig>
`mongoperf` (page 939) accepts configuration options in the form of a file that holds a *JSON* document. You must stream the content of this file into `mongoperf` (page 939), as in the following operation:

```
mongoperf < config
```

In this example `config` is the name of a file that holds a JSON document that resembles the following example:

```
{
  nThreads:<n>,
  fileSizeMB:<n>,
  sleepMicros:<n>,
  mmf:<bool>,
  r:<bool>,
  w:<bool>,
  recSizeKB:<n>,
  syncDelay:<n>
}
```

See the *Configuration Fields* (page 940) section for documentation of each of these fields.

Configuration Fields

mongoperf.**nThreads**
Type: Integer.

Default: 1

Defines the number of threads `mongoperf` (page 939) will use in the test. To saturate your system's storage system you will need multiple threads. Consider setting `nThreads` (page 940) to `16`.

mongoperf.**fileSizeMB**
Type: Integer.

Default: 1 megabyte (i.e. 1024^2 bytes)

Test file size.

mongoperf.**sleepMicros**
Type: Integer.

Default: 0

`mongoperf` (page 939) will pause for the number of specified `sleepMicros` (page 940) divided by the `nThreads` (page 940) between each operation.

mongoperf.**mmf**
Type: Boolean.

Default: `false`

Set `mmf` (page 940) to `true` to use memory mapped files for the tests.

Generally:

- when `mmf` (page 940) is `false`, `mongoperf` (page 939) tests direct, physical, I/O, without caching. Use a large file size to test heavy random I/O load and to avoid I/O coalescing.
- when `mongoperf.mmf` (page 940) is `true`, `mongoperf` (page 939) runs tests of the caching system, and can use normal file system cache. Use `mmf` in this mode to test file system cache behavior with memory mapped files.

mongoperf.**r**
Type: Boolean.

Default: `false`

Set `r` (page 940) to `true` to perform reads as part of the tests.

Either `r` (page 940) or `w` (page 940) must be `true`.

mongoperf.**w**
Type: Boolean.

Default: false

Set w (page 940) to true to perform writes as part of the tests.

Either r (page 940) or w (page 940) must be true.

mongoperf.**syncDelay**
Type: Integer.

Default: 0

Seconds between disk flushes. mongoperf.syncDelay (page 941) is similar to *--syncdelay* (page 902) for mongod (page 897).

The syncDelay (page 941) controls how frequently mongoperf (page 939) performs an asynchronous disk flush the memory mapped file used for testing. By default, mongod (page 897) performs this operation every every 60 seconds. Use syncDelay (page 941) to test basic system performance of this type of operation.

Only use syncDelay (page 941) in conjunction with mmf (page 940) set to true.

The default value of 0 disables this

Use

```
mongoperf < jsonconfigfile
```

Replace jsonconfigfile with the path to the mongoperf (page 939) configuration. You may also invoke mongoperf (page 939) in the following form:

```
echo "{nThreads:16,fileSizeMB:1000,r:true}" | ./mongoperf
```

In this operation:

- mongoperf (page 939) tests direct physical random read io's, using 16 concurrent reader threads.
- mongoperf (page 939) uses a 1 gigabyte test file.

Consider using iostat, as invoked in the following example to monitor I/O performance during the test.

```
iostat -xm 2
```

62.1.6 GridFS

mongofiles (page 942) provides a command-line interact to a MongoDB *GridFS* storage system.

mongofiles

Synopsis

The mongofiles (page 942) utility makes it possible to manipulate files stored in your MongoDB instance in *GridFS* objects from the command line. It is particularly useful as it provides an interface between objects stored in your file system and GridFS.

All mongofiles (page 942) commands take arguments in three groups:

1. *Options* (page 942). You may use one or more of these options to control the behavior of `mongofiles` (page 942).
2. *Commands* (page 942). Use one of these commands to determine the action of `mongofiles` (page 942).
3. A file name representing either the name of a file on your system's file system, a GridFS object.

`mongofiles` (page 942), like `mongodump` (page 915), `mongoexport` (page 928), `mongoimport` (page 925), and `mongorestore` (page 918), can access data stored in a MongoDB data directory without requiring a running `mongod` (page 897) instance, if no other `mongod` (page 897) is running.

Note: For *replica sets*, `mongofiles` (page 942) can only read from the set's '*primary*.

Commands

mongofiles

list <prefix>
Lists the files in the GridFS store. The characters specified after `list` (e.g. `<prefix>`) optionally limit the list of returned items to files that begin with that string of characters.

search <string>
Lists the files in the GridFS store with names that match any portion of `<string>`.

put <filename>
Copy the specified file from the local file system into GridFS storage.

Here, `<filename>` refers to the name the object will have in GridFS, and `mongofiles` (page 942) assumes that this reflects the name the file has on the local file system. If the local filename is different use the *`mongofiles --local`* (page 943) option.

get <filename>
Copy the specified file from GridFS storage to the local file system.

Here, `<filename>` refers to the name the object will have in GridFS, and `mongofiles` (page 942) assumes that this reflects the name the file has on the local file system. If the local filename is different use the *`mongofiles --local`* (page 943) option.

delete <filename>
Delete the specified file from GridFS storage.

Options

--help
Returns a basic help and usage text.

--verbose, -v
Increases the amount of internal reporting returned on the command line. Increase the verbosity with the `-v` form by including the option multiple times, (e.g. `-vvvvv`.)

--version
Returns the version of the `mongofiles` (page 942) utility.

--host `<hostname><:port>`
Specifies a resolvable hostname for the `mongod` (page 897) that holds your GridFS system. By default `mongofiles` (page 942) attempts to connect to a MongoDB process ruining on the localhost port number `27017`.

Optionally, specify a port number to connect a MongoDB instance running on a port other than 27017.

--port <port>
Specifies the port number, if the MongoDB instance is not running on the standard port. (i.e. 27017) You may also specify a port number using the *mongofiles --host* (page 942) command.

--ipv6
Enables IPv6 support that allows mongofiles (page 942) to connect to the MongoDB instance using an IPv6 network. All MongoDB programs and processes, including mongofiles (page 942), disable IPv6 support by default.

--username <username>, **-u** <username>
Specifies a username to authenticate to the MongoDB instance, if your database requires authentication. Use in conjunction with the *mongofiles --password* (page 943) option to supply a password.

--password <password>
Specifies a password to authenticate to the MongoDB instance. Use in conjunction with the *mongofiles --username* (page 943) option to supply a username.

If you specify a *--username* (page 943) without the *--password* (page 943) option, mongofiles (page 942) will prompt for a password interactively.

--dbpath <path>
Specifies the directory of the MongoDB data files. If used, the *--dbpath* (page 943) option enables mongofiles (page 942) to attach directly to local data files interact with the GridFS data without the mongod (page 897). To run with *--dbpath* (page 943), mongofiles (page 942) needs to lock access to the data directory: as a result, no mongod (page 897) can access the same path while the process runs.

--directoryperdb
Use the *--directoryperdb* (page 943) in conjunction with the corresponding option to mongod (page 897), which allows mongofiles (page 942) when running with the *--dbpath* (page 943) option and MongoDB uses an on-disk format where every database has a distinct directory. This option is only relevant when specifying the *--dbpath* (page 943) option.

--journal
Allows mongofiles (page 942) operations to use the durability *journal* when running with *--dbpath* (page 943) to ensure that the database maintains a recoverable state. This forces mongofiles (page 942) to record all data on disk regularly.

--db <db>, **-d** <db>
Use the *--db* (page 943) option to specify the MongoDB database that stores or will store the GridFS files.

--collection <collection>, **-c** <collection>
This option has no use in this context and a future release may remove it. See SERVER-4931 for more information.

--local <filename>, **-l** <filename>
Specifies the local filesystem name of a file for get and put operations.

In the **mongofiles put** and **mongofiles get** commands the required <filename> modifier refers to the name the object will have in GridFS. mongofiles (page 942) assumes that this reflects the file's name on the local file system. This setting overrides this default.

--type <MIME>, t <MIME>
Provides the ability to specify a *MIME* type to describe the file inserted into GridFS storage. mongofiles (page 942) omits this option in the default operation.

Use only with **mongofiles put** operations.

--replace, -r
Alters the behavior of **mongofiles put** to replace existing GridFS objects with the specified local file, rather than

adding an additional object with the same name.

In the default operation, files will not be overwritten by a **mongofiles put** option.

Use

To return a list of all files in a *GridFS* collection in the `records` database, use the following invocation at the system shell:

```
mongofiles -d records list
```

This `mongofiles` (page 942) instance will connect to the `mongod` (page 897) instance running on the `27017` localhost interface to specify the same operation on a different port or hostname, and issue a command that resembles one of the following:

```
mongofiles --port 37017 -d records list
mongofiles --hostname db1.example.net -d records list
mongofiles --hostname db1.example.net --port 37017 -d records list
```

Modify any of the following commands as needed if you're connecting the `mongod` (page 897) instances on different ports or hosts.

To upload a file named `32-corinth.lp` to the GridFS collection in the `records` database, you can use the following command:

```
mongofiles -d records put 32-corinth.lp
```

To delete the `32-corinth.lp` file from this GridFS collection in the `records` database, you can use the following command:

```
mongofiles -d records delete 32-corinth.lp
```

To search for files in the GridFS collection in the `records` database that have the string `corinth` in their names, you can use following command:

```
mongofiles -d records search corinth
```

To list all files in the GridFS collection in the `records` database that begin with the string `32`, you can use the following command:

```
mongofiles -d records list 32
```

To fetch the file from the GridFS collection in the `records` database named `32-corinth.lp`, you can use the following command:

```
mongofiles -d records get 32-corinth.lp
```

62.2 Configuration File Options

62.2.1 Synopsis

Administrators and users can control `mongod` (page 897) or `mongos` (page 905) instances at runtime either directly from *mongod's command line arguments* (page 897) or using a configuration file.

While both methods are functionally equivalent and all settings are similar, the configuration file method is preferable. If you installed from a package and have started MongoDB using your system's *control script*, you're already using a configuration file.

To start mongod (page 897) or mongos (page 905) using a config file, use one of the following forms:

```
mongod --config /etc/mongodb.conf
mongod -f /etc/mongodb.conf
mongos --config /srv/mongodb/mongos.conf
mongos -f /srv/mongodb/mongos.conf
```

Declare all settings in this file using the following form:

```
<setting> = <value>
```

New in version 2.0: *Before* version 2.0, Boolean (i.e. `true|false`) or "flag" parameters, register as true, if they appear in the configuration file, regardless of their value.

62.2.2 Settings

verbose
Default: false

Increases the amount of internal reporting returned on standard output or in the log file generated by logpath (page 946). To enable verbose (page 945) or to enable increased verbosity with vvvv (page 945), set these options as in the following example:

```
verbose = true
vvvv = true
```

MongoDB has the following levels of verbosity:

v
Default: false

Alternate form of verbose (page 945).

vv
Default: false

Additional increase in verbosity of output and logging.

vvv
Default: false

Additional increase in verbosity of output and logging.

vvvv
Default: false

Additional increase in verbosity of output and logging.

vvvvv
Default: false

Additional increase in verbosity of output and logging.

port
Default: 27017

Specifies a TCP port for the mongod (page 897) or mongos (page 905) instance to listen for client connections. UNIX-like systems require root access for ports with numbers lower than 1024.

bind_ip
Default: All interfaces.

Set this option to configure the mongod (page 897) or mongos (page 905) process to bind to and listen for connections from applications on this address. You may attach mongod (page 897) or mongos (page 905) instances to any interface; however, if you attach the process to a publicly accessible interface, implement proper authentication or firewall restrictions to protect the integrity of your database.

You may concatenate a list of comma separated values to bind mongod (page 897) to multiple IP addresses.

maxConns

Default: depends on system (i.e. ulimit and file descriptor) limits. Unless set, MongoDB will not limit its own connections.

Specifies a value to set the maximum number of simultaneous connections that mongod (page 897) or mongos (page 905) will accept. This setting has no effect if it is higher than your operating system's configured maximum connection tracking threshold.

This is particularly useful for mongos (page 905) if you have a client that creates a number of collections but allows them to timeout rather than close the collections. When you set maxConns (page 946), ensure the value is slightly higher than the size of the connection pool or the total number of connections to prevent erroneous connection spikes from propagating to the members of a *shard* cluster.

Note: You cannot set maxConns (page 946) to a value higher than *20000*.

---

objcheck

Default: false

Forces the mongod (page 897) to validate all requests from clients upon receipt to ensure that clients never insert invalid documents into the database. For objects with a high degree of sub-document nesting, objcheck (page 946) can have a small impact on performance. You can set noobjcheck to disable object checking at run-time.

logpath

Default: None. (i.e. http://docs.mongodb.org/v2.2/dev/stdout)

Specify the path to a file name for the log file that will hold all diagnostic logging information.

Unless specified, mongod (page 897) will output all log information to the standard output. Unless logappend (page 946) is true, the logfile will be overwritten when the process restarts.

Note: Currently, MongoDB will overwrite the contents of the log file if the logappend (page 946) is not used. This behavior may change in the future depending on the outcome of SERVER-4499.

---

logappend

Default: false

Set to true to add new entries to the end of the logfile rather than overwriting the content of the log when the process restarts.

If this setting is not specified, then MongoDB will overwrite the existing logfile upon start up.

Note: The behavior of the logging system may change in the near future in response to the SERVER-4499 case.

---

syslog

New in version 2.1.0. Sends all logging output to the host's *syslog* system rather than to standard output or a log file as with logpath (page 946).

> **Warning:** You cannot use `syslog` (page 946) with `logpath` (page 946).

pidfilepath

Default: None.

Specify a file location to hold the "*PID*" or process ID of the `mongod` (page 897) process. Useful for tracking the `mongod` (page 897) process in combination with the `fork` (page 947) setting.

Without a specified `pidfilepath` (page 947), `mongos` (page 905) creates no PID file.

Without this option, `mongod` (page 897) creates no PID file.

keyFile

Default: None.

Specify the path to a key file to store authentication information. This option is only useful for the connection between replica set members.

See Also:

"*Replica Set Security* (page 294)" and "*Replica Set Operation and Management* (page 285)."

nounixsocket

Default: false

Set to `true` to disable listening on the UNIX socket. Unless set to false, `mongod` (page 897) and `mongos` (page 905) provide a UNIX-socket.

unixSocketPrefix

Default: `http://docs.mongodb.org/v2.2/tmp`

Specifies a path for the UNIX socket. Unless this option has a value, `mongod` (page 897) and `mongos` (page 905), create a socket with the `http://docs.mongodb.org/v2.2/tmp` as a prefix.

fork

Default: false

Set to `true` to enable a *daemon* mode for `mongod` (page 897) that runs the process in the background.

auth

Default: false

Set to `true` to enable database authentication for users connecting from remote hosts. Configure users via the *mongo shell* (page 908). If no users exist, the localhost interface will continue to have access to the database until the you create the first user.

cpu

Default: false

Set to `true` to force `mongod` (page 897) to report every four seconds CPU utilization and the amount of time that the processor waits for I/O operations to complete (i.e. I/O wait.) MongoDB writes this data to standard output, or the logfile if using the `logpath` (page 946) option.

dbpath

Default: `http://docs.mongodb.org/v2.2/data/db/`

Set this value to designate a directory for the `mongod` (page 897) instance to store its data. Typical locations include: `http://docs.mongodb.org/v2.2/srv/mongodb`, `http://docs.mongodb.org/v2.2/var/lib/mongodb` or `http://docs.mongodb.org/v2.2/opt/mongodb`

Unless specified, `mongod` (page 897) will look for data files in the default `http://docs.mongodb.org/v2.2/data/db` directory. (Windows systems use the `\data\db` directory.) If you installed using a package management system. Check the

http://docs.mongodb.org/v2.2/etc/mongodb.conf file provided by your packages to see the configuration of the dbpath (page 947).

diaglog

Default: 0

Creates a very verbose, *diagnostic log* for troubleshooting and recording various errors. MongoDB writes these log files in the dbpath (page 947) directory in a series of files that begin with the string diaglog with the time logging was initiated appended as a hex string.

The value of this setting configures the level of verbosity. Possible values, and their impact are as follows.

Value	Setting
0	off. No logging.
1	Log write operations.
2	Log read operations.
3	Log both read and write operations.
7	Log write and some read operations.

You can use the mongosniff (page 938) tool to replay this output for investigation. Given a typical diaglog file, located at http://docs.mongodb.org/v2.2/data/db/diaglog.4f76a58c, you might use a command in the following form to read these files:

```
mongosniff --source DIAGLOG /data/db/diaglog.4f76a58c
```

diaglog (page 948) is for internal use and not intended for most users.

Warning: Setting the diagnostic level to 0 will cause mongod (page 897) to stop writing data to the *diagnostic log* file. However, the mongod (page 897) instance will continue to keep the file open, even if it is no longer writing data to the file. If you want to rename, move, or delete the diagnostic log you must cleanly shut down the mongod (page 897) instance before doing so.

directoryperdb

Default: false

Set to true to modify the storage pattern of the data directory to store each database's files in a distinct folder. This option will create directories within the dbpath (page 947) named for each directory.

Use this option in conjunction with your file system and device configuration so that MongoDB will store data on a number of distinct disk devices to increase write throughput or disk capacity.

journal

Default: (on 64-bit systems) true

Default: (on 32-bit systems) false

Set to true to enable operation journaling to ensure write durability and data consistency.

Set to false to prevent the overhead of journaling in situations where durability is not required. To reduce the impact of the journaling on disk usage, you can leave journal (page 948) enabled, and set smallfiles (page 950) to true to reduce the size of the data and journal files.

journalCommitInterval

Default: 100

Set this value to specify the maximum amount of time for mongod (page 897) to allow between journal operations. The default value is 100 milliseconds. Lower values increase the durability of the journal, at the possible expense of disk performance.

This option accepts values between 2 and 300 milliseconds.

To force mongod (page 897) to commit to the journal more frequently, you can specify j:true. When a write operation with j:true pending, mongod (page 897) will reduce journalCommitInterval (page 948) to a third of the set value.

ipv6

Default: false

Set to true to IPv6 support to allow clients to connect to mongod (page 897) using IPv6 networks. mongod (page 897) disables IPv6 support by default in mongod (page 897) and all utilities.

jsonp

Default: false

Set to true to permit *JSONP* access via an HTTP interface. Consider the security implications of allowing this activity before setting this option.

noauth

Default: true

Disable authentication. Currently the default. Exists for future compatibility and clarity.

For consistency use the auth (page 947) option.

nohttpinterface

Default: false

Set to true to disable the HTTP interface. This command will override the rest (page 950) and disable the HTTP interface if you specify both. Changed in version 2.1.2: The nohttpinterface (page 949) option is not available for mongos (page 905) instances before 2.1.2

nojournal

Default: (on 64-bit systems) false

Default: (on 32-bit systems) true

Set nojournal = true to disable durability journaling. By default, mongod (page 897) enables journaling in 64-bit versions after v2.0.

noprealloc

Default: false

Set noprealloc = true to disable the preallocation of data files. This will shorten the start up time in some cases, but can cause significant performance penalties during normal operations.

noscripting

Default: false

Set noscripting = true to disable the scripting engine.

notablescan

Default: false

Set notablescan = true to forbid operations that require a table scan.

nssize

Default: 16

Specify this value in megabytes. The maximum size is 2047 megabytes.

Use this setting to control the default size for all newly created namespace files (i.e .ns). This option has no impact on the size of existing namespace files.

See Limits on namespaces (page 1021).

profile

Default: 0

Modify this value to changes the level of database profiling, which inserts information about operation performance into output of mongod (page 897) or the log file if specified by logpath (page 946). The following levels are available:

Level	Setting
0	Off. No profiling.
1	On. Only includes slow operations.
2	On. Includes all operations.

By default, mongod (page 897) disables profiling. Database profiling can impact database performance because the profiler must record and process all database operations. Enable this option only after careful consideration.

quota

Default: false

Set to true to enable a maximum limit for the number data files each database can have. The default quota is 8 data files, when quota is true. Adjust the quota size with the with the quotaFiles (page 950) setting.

quotaFiles

Default: 8

Modify limit on the number of data files per database. This option requires the quota (page 950) setting.

rest

Default: false

Set to true to enable a simple *REST* interface.

repair

Default: false

Set to true to run a repair routine on all databases following start up. In general you should set this option on the command line and *not* in the *configuration file* (page 33) or in a *control script*.

Use the *mongod --repair* (page 901) option to access this functionality.

Note: Because mongod (page 897) rewrites all of the database files during the repair routine, if you do not run repair (page 950) under the same user account as mongod (page 897) usually runs, you will need to run chown on your database files to correct the permissions before starting mongod (page 897) again.

---

repairpath

Default: A _tmp directory in the dbpath (page 947).

Specify the path to the directory containing MongoDB data files, to use in conjunction with the repair (page 950) setting or *mongod --repair* (page 901) operation. Defaults to a _tmp directory within the dbpath (page 947).

slowms

Default: 100

Specify values in milliseconds.

Sets the threshold for mongod (page 897) to consider a query "slow" for the database profiler. The database logs all slow queries to the log, even when the profiler is not turned on. When the database profiler is on, mongod (page 897) the profiler writes to the system.profile collection.

See Also:

"profile (page 949)"

smallfiles

Default: false

Set to `true` to modify MongoDB to use a smaller default data file size. Specifically, `smallfiles` (page 950) reduces the initial size for data files and limits them to 512 megabytes. The `smallfiles` (page 950) setting also reduces the size of each *journal* files from 1 gigabyte to 128 megabytes.

Use the `smallfiles` (page 950) setting if you have a large number of databases that each hold a small quantity of data. The `smallfiles` (page 950) setting can lead `mongod` (page 897) to create many files, which may affect performance for larger databases.

syncdelay

Default: 60

`mongod` (page 897) writes data very quickly to the journal, and lazily to the data files. `syncdelay` (page 951) controls how much time can pass before MongoDB flushes data to the *database files* via an *fsync* operation. The default setting is 60 seconds. In almost every situation you should not set this value and use the default setting.

The `serverStatus` (page 792) command reports the background flush thread's status via the `backgroundFlushing` (page 972) field.

`syncdelay` (page 951) has no effect on the `journal` (page 948) files or *journaling* (page 41).

Warning: If you set `syncdelay` (page 951) to `0`, MongoDB will not sync the memory mapped files to disk. Do not set this value on production systems.

sysinfo

Default: false

When set to `true`, `mongod` (page 897) returns diagnostic system information regarding the page size, the number of physical pages, and the number of available physical pages to standard output.

More typically, run this operation by way of the *`mongod --sysinfo`* (page 902) command. When running with the `sysinfo` (page 951), only `mongod` (page 897) only outputs the page information and no database process will start.

upgrade

Default: false

When set to `true` this option upgrades the on-disk data format of the files specified by the `dbpath` (page 947) to the latest version, if needed.

This option only affects the operation of `mongod` (page 897) if the data files are in an old format.

When specified for a `mongos` (page 905) instance, this option updates the meta data format used by the *config database*.

Note: In most cases you should **not** set this value, so you can exercise the most control over your upgrade process. See the MongoDB release notes (on the download page) for more information about the upgrade process.

---

traceExceptions

Default: false

For internal diagnostic use only.

quiet

Default: false

Runs the mongod (page 897) or mongos (page 905) instance in a quiet mode that attempts to limit the amount of output. This option suppresses:

- output from *database commands*, including drop (page 754), dropIndexes (page 755), diagLogging (page 753), validate (page 799), and clean (page 742).
- replication activity.
- connection accepted events.
- connection closed events.

Note: For production systems this option is **not** recommended as it may make tracking problems during particular connections much more difficult.

Replication Options

replSet

Default: <none>

Form: <setname>

Use this setting to configure replication with replica sets. Specify a replica set name as an argument to this set. All hosts must have the same set name.

See Also:

"*Replication* (page 277)," "*Replica Set Operation and Management* (page 285)," and "*Replica Set Configuration* (page 989)"

oplogSize

Specifies a maximum size in megabytes for the replication operation log (e.g. *oplog*.) mongod (page 897) creates an oplog based on the maximum amount of space available. For 64-bit systems, the oplog is typically 5% of available disk space.

Once the mongod (page 897) has created the oplog for the first time, changing oplogSize (page 952) will not affect the size of the oplog.

fastsync

Default: false

In the context of *replica set* replication, set this option to true if you have seeded this member with a snapshot of the *dbpath* of another member of the set. Otherwise the mongod (page 897) will attempt to perform an initial sync, as though the member were a new member.

> **Warning:** If the data is not perfectly synchronized *and* mongod (page 897) starts with fastsync (page 952), then the secondary or slave will be permanently out of sync with the primary, which may cause significant consistency problems.

replIndexPrefetch

New in version 2.2. *Default:* all

Values: all, none, and _id_only

You can only use replIndexPrefetch (page 952) in conjunction with replSet (page 952).

By default *secondary* members of a *replica set* will load all indexes related to an operation into memory before applying operations from the oplog. You can modify this behavior so that the secondaries will only load the _id index. Specify _id_only or none to prevent the mongod (page 897) from loading *any* index into memory.

Master/Slave Replication

master
Default: false

Set to `true` to configure the current instance to act as *master* instance in a replication configuration.

slave
Default: false

Set to `true` to configure the current instance to act as *slave* instance in a replication configuration.

source
Default: <>

Form: <host><:port>

Used with the `slave` (page 953) setting to specify the *master* instance from which this *slave* instance will replicate

only
Default: <>

Used with the `slave` (page 953) option, `only` (page 953) specifies only a single *database* to replicate.

slaveDelay
Default: 0

Used with the `slave` (page 953) setting, `slaveDelay` (page 953) configures a "delay" in seconds, for this slave to wait to apply operations from the *master* instance.

autoresync
Default: false

Used with the `slave` (page 953) setting, set `autoresync` (page 953) to `true` to force the *slave* to automatically resync if it is more than 10 seconds behind the master. This setting may be problematic if the `--oplogSize` of the *oplog* is too small (controlled by the *`--oplogSize`* (page 903) option.) If the *oplog* is not large enough to store the difference in changes between the master's current state and the state of the slave, this instance will forcibly resync itself unnecessarily. When you set the `autoresync` (page 953) option to `false`, the slave will not attempt an automatic resync more than once in a ten minute period.

Sharded Cluster Options

configsvr
Default: false

Set this value to `true` to configure this `mongod` (page 897) instance to operate as the *config database* of a shard cluster. When running with this option, clients will not be able to write data to any database other than `config` and `admin`. The default port for a `mongod` (page 897) with this option is `27019` and the default `dbpath` (page 947) directory is `http://docs.mongodb.org/v2.2/data/configdb`, unless specified. Changed in version 2.2: `configsvr` (page 953) also sets `smallfiles` (page 950). Do not use `configsvr` (page 953) with `replSet` (page 952) or `shardsvr` (page 953). Config servers cannot be a shard server or part of a *replica set*.

default port for `mongod` (page 897) with this option is `27019` and `mongod` (page 897) writes all data files to the `http://docs.mongodb.org/v2.2/configdb` sub-directory of the `dbpath` (page 947) directory.

shardsvr
Default: false

Set this value to `true` to configure this `mongod` (page 897) instance as a shard in a partitioned cluster. The default port for these instances is `27018`. The only affect of `shardsvr` (page 953) is to change the port number.

noMoveParanoia

Default: false

When set to `true`, `noMoveParanoia` (page 954) disables a "paranoid mode" for data writes for chunk migration operation. See the *chunk migration* (page 380) and `moveChunk` (page 782) command documentation for more information.

By default `mongod` (page 897) will save copies of migrated chunks on the "from" server during migrations as "paranoid mode." Setting this option disables this paranoia.

configdb

Default: None.

Format: `<config1>,<config2><:port>,<config3>`

Set this option to specify a configuration database (i.e. *config database*) for the *sharded cluster*. You must specify either 1 configuration server or 3 configuration servers, in a comma separated list.

This setting only affects `mongos` (page 905) processes.

Note: `mongos` (page 905) instances read from the first *config server* in the list provided. All `mongos` (page 905) instances **must** specify the hosts to the `configdb` (page 954) setting in the same order.

If your configuration databases reside in more that one data center, order the hosts in the `configdb` (page 954) setting so that the config database that is closest to the majority of your `mongos` (page 905) instances is first servers in the list.

Warning: Never remove a config server from the `configdb` (page 954) parameter, even if the config server or servers are not available, or offline.

test

Default: false

Only runs unit tests and does not start a `mongos` (page 905) instance.

This setting only affects `mongos` (page 905) processes and is for internal testing use only.

chunkSize

Default: 64

The value of this option determines the size of each *chunk* of data distributed around the *sharded cluster*. The default value is 64 megabytes. Larger chunks may lead to an uneven distribution of data, while smaller chunks may lead to frequent and unnecessary migrations. However, in some circumstances it may be necessary to set a different chunk size.

This setting only affects `mongos` (page 905) processes. Furthermore, `chunkSize` (page 954) *only* sets the chunk size when initializing the cluster for the first time. If you modify the run-time option later, the new value will have no effect. See the "*Modify Chunk Size* (page 394)" procedure if you need to change the chunk size on an existing sharded cluster.

localThreshold

New in version 2.2. `localThreshold` (page 954) affects the logic that program:*mongos* uses when selecting *replica set* members to pass reads operations to from clients. Specify a value to `localThreshold` (page 954) in milliseconds. The default value is `15`, which corresponds to the default value in all of the client *drivers* (page 435).

This setting only affects mongos (page 905) processes.

When mongos (page 905) receives a request that permits reads to *secondary* members, the mongos (page 905) will:

- find the member of the set with the lowest ping time.
- construct a list of replica set members that is within a ping time of 15 milliseconds of the nearest suitable member of the set.

  If you specify a value for localThreshold (page 954), mongos (page 905) will construct the list of replica members that are within the latency allowed by this value.
- The mongos (page 905) will select a member to read from at random from this list.

The ping time used for a set member compared by the *--localThreshold* (page 907) setting is a moving average of recent ping times, calculated, at most, every 10 seconds. As a result, some queries may reach members above the threshold until the mongos (page 905) recalculates the average.

See the *Member Selection* (page 310) section of the *read preference* (page 306) documentation for more information.

noAutoSplit

noAutoSplit (page 955) is for internal use and is only available on mongos (page 905) instances. New in version 2.0.7. noAutoSplit (page 955) prevents mongos (page 905) from automatically inserting metadata splits in a *sharded collection*. If set on all mongos (page 905), this will prevent MongoDB from creating new chunks as the data in a collection grows.

Because any mongos (page 905) in a cluster can create a split, to totally disable splitting in a cluster you must set noAutoSplit (page 955) on all mongos (page 905).

Warning: With noAutoSplit (page 955) enabled, the data in your sharded cluster may become imbalanced over time. Enable with caution.

62.3 Connection String URI Format

This document describes the URI format for defining connections between applications and MongoDB instances in the official MongoDB *drivers* (page 435).

62.3.1 Standard Connection String Format

This section describes the standard format of the MongoDB connection URI used to connect to a MongoDB database server. The format is the same for all official MongoDB drivers. For a list of drivers and links to driver documentation, see *MongoDB Drivers and Client Libraries* (page 435).

The following is the standard URI connection scheme:

```
mongodb://[username:password@]host1[:port1][,host2[:port2],...[,hostN[:portN]]][/[database][?options]
```

The components of this string are:

1. `mongodb://`

   A required prefix to identify that this is a string in the standard connection format.

2. `username:password@`

   Optional. If specified, the client will attempt to log in to the specific database using these credentials after connecting to the mongod (page 897) instance.

3. `host1`

   This the only required part of the URI. It identifies a server address to connect to. It identifies either a hostname, IP address, or UNIX domain socket.

4. `:port1`

   Optional. The default value is `:27017` if not specified.

5. `hostX`

   Optional. You can specify as many hosts as necessary. You would specify multiple hosts, for example, for connections to replica sets.

6. `:portX`

   Optional. The default value is `:27017` if not specified.

7. `http://docs.mongodb.org/v2.2/database`

   Optional. The name of the database to authenticate if the connection string includes authentication credentials in the form of `username:password@`. If `http://docs.mongodb.org/v2.2/database` is not specified and the connection string includes credentials, the driver will authenticate to the `admin` database.

8. `?options`

   Connection specific options. See *Connection String Options* (page 956) for a full description of these options.

   If the connection string does not specify a database/ you must specify a slash (i.e. `http://docs.mongodb.org/v2.2/`) between the last `hostN` and the question mark that begins the string of options.

Example

To describe a connection to a replica set named `test`, with the following `mongod` (page 897) hosts:

- `db1.example.net` on port `27017` and
- `db2.example.net` on port `2500`.

You would use a connection string that resembles the following:

```
mongodb://db1.example.net,db2.example.net:2500/?replicaSet=test
```

62.3.2 Connection String Options

This section lists all connection options used in the *Standard Connection String Format* (page 955).The options are not case-sensitive.

Connection options are pairs in the following form: `name=value`. Separate options with the ampersand (i.e. `&`) character. In the following example, a connection uses the `replicaSet` and `connectTimeoutMS` options:

```
mongodb://db1.example.net,db2.example.net:2500/?replicaSet=test&connectTimeoutMS=300000
```

Semi-colon separator for connection string arguments

To provide backwards compatibility, drivers currently accept semi-colons (i.e. `;`) as option separators.

Replica Set Option

uri.**replicaSet**
Specifies the name of the *replica set*, if the mongod (page 897) is a member of a replica set.

When connecting to a replica set it is important to give a seed list of at least two mongod (page 897) instances. If you only provide the connection point of a single mongod (page 897) instance, and omit the replicaSet (page 957), the client will create a *standalone* connection.

Connection Options

uri.**ssl**
true: Initiate the connection with SSL.

false: Initiate the connection without SSL.

The default value is false.

Note: The ssl (page 957) option is not supported by all drivers. See your *driver* (page 435) documentation and the *Use MongoDB with SSL Connections* (page 47) document.

---

uri.**connectTimeoutMS**
The time in milliseconds to attempt a connection before timing out. The default is never to timeout, though different drivers might vary. See the *driver* (page 435) documentation.

uri.**socketTimeoutMS**
The time in milliseconds to attempt a send or receive on a socket before the attempt times out. The default is never to timeout, though different drivers might vary. See the *driver* (page 435) documentation.

Connection Pool Options

Most drivers implement some kind of connection pooling handle this for you behind the scenes. Some drivers do not support connection pools. See your *driver* (page 435) documentation for more information on the connection pooling implementation. These options allow applications to configure the connection pool when connecting to the MongoDB deployment.

uri.**maxPoolSize**
The maximum number of connections in the connection pool. The default value is 100.

uri.**minPoolSize**
The minimum number of connections in the connection pool. The default value is 0.

Note: The minPoolSize (page 957) option is not supported by all drivers. For information on your driver, see the *drivers* (page 435) documentation.

---

uri.**maxIdleTimeMS**
The maximum number of milliseconds that a connection can remain idle in the pool before being removed and closed.

This option is not supported by all drivers.

uri.**waitQueueMultiple**
A number that the driver multiples the maxPoolSize (page 957) value to, to provide the maximum number of threads allowed to wait for a connection to become available from the pool. For default values, see the *MongoDB Drivers and Client Libraries* (page 435) documentation.

uri.**waitQueueTimeoutMS**
The maximum time in milliseconds that a thread can wait for a connection to become available. For default values, see the *MongoDB Drivers and Client Libraries* (page 435) documentation.

Write Concern Options

Write concern (page 124) describes the kind of assurances that the program:*mongod* and the driver provide to the application regarding the success and durability of the write operation. For a full explanation of write concern and write operations in general see the: *Write Operations* (page 123):

uri.**w**
Defines the level and kind of write concern, that the driver uses when calling `getLastError` (page 766). This option can take either a number or a string as a value.

Options

- **-1** – The driver will *not* acknowledge write operations and will suppress all network or socket errors.
- **0** – The driver will *not* acknowledge write operations, but will pass or handle any network and socket errors that it receives to the client.

  If you disable write concern but enable the `getLastError` (page 766) command's `journal` option, `journal` overrides this `w` option.
- **1** – Provides basic acknowledgment of write operations.

  By specifying `1`, you require that a standalone `mongod` (page 897) instance, or the primary for *replica sets*, acknowledge all write operations. For drivers released after the *default write concern change* (page 1061), this is the default write concern setting.
- **majority** (*string*) – For replica sets, if you specify the special `majority` value to `w` (page 958) option, write operations will only return successfully after a majority of the configured replica set members have acknowledged the write operation.
- **n** (*number*) – For replica sets, if you specify a number greater than 1, operations with this write concern will only return after this many members of the set have acknowledged the write.

  If you set `w` to a number that is greater than the number of available set members, or members that hold data, MongoDB will wait, potentially indefinitely, for these members to become available.
- **tags** (*string*) – For replica sets, you can specify a *tag set* (page 994) to require that all members of the set that have these tags configured return confirmation of the write operation.

  See *Replica Set Tag Set Configuration* (page 994) for more information.

uri.**wtimeoutMS**
The time in milliseconds to wait for replication to succeed, as specified in the `w` (page 958) option, before timing out.

uri.**journal**
Controls whether write operations will wait till the `mongod` (page 897) acknowledges the write operations and commits the data to the on disk *journal*.

Options

- **true** (*boolean*) – Enables journal commit acknowledgment write concern. Equivalent to specifying the `getLastError` (page 766) command with the `j` option enabled.
- **false** (*boolean*) –

Does not require that mongod (page 897) commit write operations to the journal before acknowledging the write operation. This is the *default* option for the journal (page 958) parameter.

If you set journal (page 958) to true, and specify a w (page 958) value less than 1, journal (page 958) prevails.

If you set journal (page 958) to true, and the mongod (page 897) does not have journaling enabled, as with nojournal (page 949), then getLastError (page 766) will provide basic receipt acknowledgment (i.e. w:1), and will include a jnote field in its return document.

Read Preference Options

Read preferences (page 306) describe the behavior of read operations with regards to *replica sets*. These parameters allow you to specify read preferences on a per-connection basis in the connection string:

uri.**readPreference**

Specifies the *replica set* read preference for this connection. This setting overrides any slaveOk value. The read preference values are the following:

- primary (page 307)
- primaryPreferred (page 307)
- secondary (page 307)
- secondaryPreferred (page 307)
- nearest (page 308)

For descriptions of each value, see *Read Preference Modes* (page 306).

The default value is primary (page 307), which sends all read operations to the replica set's *primary*.

uri.**readPreferenceTags**

Specifies a tag set as a comma-separated list of colon-separated key-value pairs. For example:

```
dc:ny,rack:1
```

To specify a *list* of tag sets, use multiple readPreferenceTags. The following specifies two tag sets and an empty tag set:

```
readPreferenceTags=dc:ny,rack:1&readPreferenceTags=dc:ny&readPreferenceTags=
```

Order matters when using multiple readPreferenceTags.

Miscellaneous Configuration

uri.**uuidRepresentation**

Parameters

- **standard** – The standard binary representation.
- **csharpLegacy** – The default representation for the C# driver.
- **javaLegacy** – The default representation for the Java driver.
- **pythonLegacy** – The default representation for the Python driver.

For the default, see the *drivers* (page 435) documentation for your driver.

Note: Not all drivers support the `uuidRepresentation` (page 959) option. For information on your driver, see the *drivers* (page 435) documentation.

62.3.3 Examples

Consider the following example MongoDB URI strings, that specify common connections:

- Connect to a database server running locally on the default port:

  ```
  mongodb://localhost
  ```

- Connect and log in to the `admin` database as user `sysop` with the password `moon`:

  ```
  mongodb://sysop:moon@localhost
  ```

- Connect and log in to the `records` database as user `sysop` with the password `moon`:

  ```
  mongodb://sysop:moon@localhost/records
  ```

- Connect to a UNIX domain socket:

  ```
  mongodb:///tmp/mongodb-27017.sock
  ```

  Note: Not all drivers support UNIX domain sockets. For information on your driver, see the *drivers* (page 435) documentation.

- Connect to a *replica set* with two members, one on `db1.example.net` and the other on `db2.example.net`:

  ```
  mongodb://db1.example.net,db2.example.com
  ```

- Connect to a replica set with three members running on `localhost`, on ports `27017`, `27018`, and `27019`:

  ```
  mongodb://localhost,localhost:27018,localhost:27019
  ```

- Connect to a replica set with three members. Send all writes to the *primary* and distribute reads to the *secondaries*:

  ```
  mongodb://example1.com,example2.com,example3.com/?readPreference=secondary
  ```

- Connect to a replica set with write concern configured to wait for replication to succeed on at least two members, with a two-second timeout.

  ```
  mongodb://example1.com,example2.com,example3.com/?w=2&wtimeoutMS=2000
  ```

CHAPTER 63

Status and Reporting

63.1 Server Status Output Index

This document provides a quick overview and example of the `serverStatus` (page 792) command. The helper `db.serverStatus()` (page 854) in the `mongo` (page 908) shell provides access to this output. For full documentation of the content of this output, see *Server Status Reference* (page 965).

Note: The fields included in this output vary slightly depending on the version of MongoDB, underlying operating system platform, and the kind of node, including `mongos` (page 905), `mongod` (page 897) or *replica set* member.

The "*Instance Information* (page 965)" section displays information regarding the specific `mongod` (page 897) and `mongos` (page 905) and its state.

```
{
        "host" : "<hostname>",
        "version" : "<version>",
        "process" : "<mongod|mongos>",
        "pid" : <num>,
        "uptime" : <num>,
        "uptimeMillis" : <num>,
        "uptimeEstimate" : <num>,
        "localTime" : ISODate(""),
```

The "*locks* (page 966)" section reports data that reflect the state and use of both global (i.e. `.`) and database specific locks:

```
"locks" : {
        "." : {
                "timeLockedMicros" : {
                        "R" : <num>,
                        "W" : <num>
                },
                "timeAcquiringMicros" : {
                        "R" : <num>,
                        "W" : <num>
                }
        },
        "admin" : {
```

```
                "timeLockedMicros" : {
                        "r" : <num>,
                        "w" : <num>
                },
                "timeAcquiringMicros" : {
                        "r" : <num>,
                        "w" : <num>
                }
        },
        "local" : {
                "timeLockedMicros" : {
                        "r" : <num>,
                        "w" : <num>
                },
                "timeAcquiringMicros" : {
                        "r" : <num>,
                        "w" : <num>
                }
        },
        "<database>" : {
                "timeLockedMicros" : {
                        "r" : <num>,
                        "w" : <num>
                },
                "timeAcquiringMicros" : {
                        "r" : <num>,
                        "w" : <num>
                }
        }
},
```

The "*globalLock* (page 968)" field reports on MongoDB's global system lock. In most cases the *locks* (page 966) document provides more fine grained data that reflects lock use:

```
"globalLock" : {
        "totalTime" : <num>,
        "lockTime" : <num>,
        "currentQueue" : {
                "total" : <num>,
                "readers" : <num>,
                "writers" : <num>
        },
        "activeClients" : {
                "total" : <num>,
                "readers" : <num>,
                "writers" : <num>
        }
},
```

The "*mem* (page 969)" field reports on MongoDB's current memory use:

```
"mem" : {
        "bits" : <num>,
        "resident" : <num>,
        "virtual" : <num>,
        "supported" : <boolean>,
        "mapped" : <num>,
        "mappedWithJournal" : <num>
},
```

The "*connections* (page 970)" field reports on MongoDB's current memory use by the MongoDB process:

```
"connections" : {
        "current" : <num>,
        "available" : <num>
},
```

The fields in the "*extra_info* (page 971)" document provide platform specific information. The following example block is from a Linux-based system:

```
"extra_info" : {
        "note" : "fields vary by platform",
        "heap_usage_bytes" : <num>,
        "page_faults" : <num>
},
```

The "*indexCounters* (page 971)" document reports on index use:

```
"indexCounters" : {
        "btree" : {
                "accesses" : <num>,
                "hits" : <num>,
                "misses" : <num>,
                "resets" : <num>,
                "missRatio" : <num>
        }
},
```

The "*backgroundFlushing* (page 972)" document reports on the process MongoDB uses to write data to disk:

```
"backgroundFlushing" : {
        "flushes" : <num>,
        "total_ms" : <num>,
        "average_ms" : <num>,
        "last_ms" : <num>,
        "last_finished" : ISODate("")
},
```

The "*cursors* (page 973)" document reports on current cursor use and state:

```
"cursors" : {
        "totalOpen" : <num>,
        "clientCursors_size" : <num>,
        "timedOut" : <num>
},
```

The "*network* (page 973)" document reports on network use and state:

```
"network" : {
        "bytesIn" : <num>,
        "bytesOut" : <num>,
        "numRequests" : <num>
},
```

The "*repl* (page 973)" document reports on the state of replication and the *replica set*. This document only appears for replica sets.

```
"repl" : {
        "setName" : "<string>",
        "ismaster" : <boolean>,
        "secondary" : <boolean>,
```

```
        "hosts" : [
                <hostname>,
                <hostname>,
                <hostname>
        ],
        "primary" : <hostname>,
        "me" : <hostname>
},
```

The "*opcountersRepl* (page 974)" document reports the number of replicated operations:

```
"opcountersRepl" : {
        "insert" : <num>,
        "query" : <num>,
        "update" : <num>,
        "delete" : <num>,
        "getmore" : <num>,
        "command" : <num>
},
```

The "*replNetworkQueue* (page 975)" document holds information regarding the queue that *secondaries* use to poll data from other members of their set:

```
"replNetworkQueue" : {
        "waitTimeMs" : <num>,
        "numElems" : <num>,
        "numBytes" : <num>
},
```

The "*opcounters* (page 975)" document reports the number of operations this MongoDB instance has processed:

```
"opcounters" : {
        "insert" : <num>,
        "query" : <num>,
        "update" : <num>,
        "delete" : <num>,
        "getmore" : <num>,
        "command" : <num>
},
```

The "*asserts* (page 976)" document reports the number of assertions or errors produced by the server:

```
"asserts" : {
        "regular" : <num>,
        "warning" : <num>,
        "msg" : <num>,
        "user" : <num>,
        "rollovers" : <num>
},
```

The "*writeBacksQueued* (page 977)" document reports the number of *writebacks*:

```
"writeBacksQueued" : <num>,
```

The "*dur* (page 977)" document reports on data that reflect this `mongod` (page 897) instance's journaling-related operations and performance during a *journal group commit interval* (page 43):

```
"dur" : {
        "commits" : <num>,
        "journaledMB" : <num>,
```

```
        "writeToDataFilesMB" : <num>,
        "compression" : <num>,
        "commitsInWriteLock" : <num>,
        "earlyCommits" : <num>,
        "timeMs" : {
                "dt" : <num>,
                "prepLogBuffer" : <num>,
                "writeToJournal" : <num>,
                "writeToDataFiles" : <num>,
                "remapPrivateView" : <num>
        }
},
```

The "*recordStats* (page 978)" document reports data on MongoDB's ability to predict page faults and yield write operations when required data isn't in memory:

```
"recordStats" : {
        "accessesNotInMemory" : <num>,
        "pageFaultExceptionsThrown" : <num>,
        "local" : {
                "accessesNotInMemory" : <num>,
                "pageFaultExceptionsThrown" : <num>
        },
        "<database>" : {
                "accessesNotInMemory" : <num>,
                "pageFaultExceptionsThrown" : <num>
        }
},
```

The final `ok` field holds the return status for the `serverStatus` (page 792) command:

```
        "ok" : 1
}
```

63.2 Server Status Reference

The `serverStatus` (page 792) command returns a collection of information that reflects the database's status. These data are useful for diagnosing and assessing the performance of your MongoDB instance. This reference catalogs each datum included in the output of this command and provides context for using this data to more effectively administer your database.

See Also:

Much of the output of `serverStatus` (page 792) is also displayed dynamically by `mongostat` (page 931). See the *mongostat* (page 931) command for more information.

For examples of the `serverStatus` (page 792) output, see *Server Status Output Index* (page 961).

63.2.1 Instance Information

Example

output of the instance information fields (page 961).

serverStatus.**host**
The host (page 965) field contains the system's hostname. In Unix/Linux systems, this should be the same as the output of the hostname command.

serverStatus.**version**
The version (page 966) field contains the version of MongoDB running on the current mongod (page 897) or mongos (page 905) instance.

serverStatus.**process**
The process (page 966) field identifies which kind of MongoDB instance is running. Possible values are:

- mongos (page 905)
- mongod (page 897)

serverStatus.**uptime**
The value of the uptime (page 966) field corresponds to the number of seconds that the mongos (page 905) or mongod (page 897) process has been active.

serverStatus.**uptimeEstimate**
uptimeEstimate (page 966) provides the uptime as calculated from MongoDB's internal course-grained time keeping system.

serverStatus.**localTime**
The localTime (page 966) value is the current time, according to the server, in UTC specified in an ISODate format.

63.2.2 locks

New in version 2.1.2: All locks (page 966) statuses first appeared in the 2.1.2 development release for the 2.2 series.

Example

output of the locks fields (page 961).

---

serverStatus.**locks**
The locks (page 966) document contains sub-documents that provides a granular report on MongoDB database-level lock use. All values are of the NumberLong() type.

Generally, fields named:

- R refer to the global read lock,
- W refer to the global write lock,
- r refer to the database specific read lock, and
- w refer to the database specific write lock.

If a document does not have any fields, it means that no locks have existed with this context since the last time the mongod (page 897) started.

serverStatus.locks..
A field named . holds the first document in locks (page 966) that contains information about the global lock.

serverStatus.locks...**timeLockedMicros**
The timeLockedMicros (page 966) document reports the amount of time in microseconds that a lock has existed in all databases in this mongod (page 897) instance.

serverStatus.locks...timeLockedMicros.**R**
The R field reports the amount of time in microseconds that any database has held the global read lock.

serverStatus.locks...timeLockedMicros.**W**
: The W field reports the amount of time in microseconds that any database has held the global write lock.

serverStatus.locks...timeLockedMicros.**r**
: The r field reports the amount of time in microseconds that any database has held the local read lock.

serverStatus.locks...timeLockedMicros.**w**
: The w field reports the amount of time in microseconds that any database has held the local write lock.

serverStatus.locks...**timeAcquiringMicros**
: The timeAcquiringMicros (page 967) document reports the amount of time in microseconds that operations have spent waiting to acquire a lock in all databases in this mongod (page 897) instance.

serverStatus.locks...timeAcquiringMicros.**R**
: The R field reports the amount of time in microseconds that any database has spent waiting for the global read lock.

serverStatus.locks...timeAcquiringMicros.**W**
: The W field reports the amount of time in microseconds that any database has spent waiting for the global write lock.

serverStatus.locks.**admin**
: The admin (page 967) document contains two sub-documents that report data regarding lock use in the *admin database*.

serverStatus.locks.admin.**timeLockedMicros**
: The timeLockedMicros (page 967) document reports the amount of time in microseconds that locks have existed in the context of the *admin database*.

serverStatus.locks.admin.timeLockedMicros.**r**
: The r field reports the amount of time in microseconds that the *admin database* has held the read lock.

serverStatus.locks.admin.timeLockedMicros.**w**
: The w field reports the amount of time in microseconds that the *admin database* has held the write lock.

serverStatus.locks.admin.**timeAcquiringMicros**
: The timeAcquiringMicros (page 967) document reports on the amount of field time in microseconds that operations have spent waiting to acquire a lock for the *admin database*.

serverStatus.locks.admin.timeAcquiringMicros.**r**
: The r field reports the amount of time in microseconds that operations have spent waiting to acquire a read lock on the *admin database*.

serverStatus.locks.admin.timeAcquiringMicros.**w**
: The w field reports the amount of time in microseconds that operations have spent waiting to acquire a write lock on the *admin database*.

serverStatus.locks.**local**
: The local (page 967) document contains two sub-documents that report data regarding lock use in the local database. The local database contains a number of instance specific data, including the *oplog* for replication.

serverStatus.locks.local.**timeLockedMicros**
: The timeLockedMicros (page 967) document reports on the amount of time in microseconds that locks have existed in the context of the local database.

serverStatus.locks.local.timeLockedMicros.**r**
: The r field reports the amount of time in microseconds that the local database has held the read lock.

serverStatus.locks.local.timeLockedMicros.**w**
: The w field reports the amount of time in microseconds that the local database has held the write lock.

serverStatus.locks.local.**timeAcquiringMicros**
: The timeAcquiringMicros (page 967) document reports on the amount of time in microseconds that operations have spent waiting to acquire a lock for the local database.

serverStatus.locks.local.timeAcquiringMicros.**r**
: The r field reports the amount of time in microseconds that operations have spent waiting to acquire a read lock on the local database.

serverStatus.locks.local.timeAcquiringMicros.**w**
: The w field reports the amount of time in microseconds that operations have spent waiting to acquire a write lock on the local database.

serverStatus.locks.**<database>**
: For each additional database locks (page 966) includes a document that reports on the lock use for this database. The names of these documents reflect the database name itself.

serverStatus.locks.<database>.**timeLockedMicros**
: The timeLockedMicros (page 968) document reports on the amount of time in microseconds that locks have existed in the context of the <database> database.

serverStatus.locks.<database>.timeLockedMicros.**r**
: The r field reports the amount of time in microseconds that the <database> database has held the read lock.

serverStatus.locks.<database>.timeLockedMicros.**w**
: The w field reports the amount of time in microseconds that the <database> database has held the write lock.

serverStatus.locks.<database>.**timeAcquiringMicros**
: The timeAcquiringMicros (page 968) document reports on the amount of time in microseconds that operations have spent waiting to acquire a lock for the <database> database.

serverStatus.locks.<database>.timeAcquiringMicros.**r**
: The r field reports the amount of time in microseconds that operations have spent waiting to acquire a read lock on the <database> database.

serverStatus.locks.<database>.timeAcquiringMicros.**w**
: The w field reports the amount of time in microseconds that operations have spent waiting to acquire a write lock on the <database> database.

63.2.3 globalLock

Example

output of the globalLock fields (page 962).

serverStatus.**globalLock**
: The globalLock (page 968) data structure contains information regarding the database's current lock state, historical lock status, current operation queue, and the number of active clients.

serverStatus.globalLock.**totalTime**
: The value of totalTime (page 968) represents the time, in microseconds, since the database last started and creation of the globalLock (page 968). This is roughly equivalent to total server uptime.

serverStatus.globalLock.**lockTime**
: The value of lockTime (page 968) represents the time, in microseconds, since the database last started, that the globalLock (page 968) has been *held*.

  Consider this value in combination with the value of totalTime (page 968). MongoDB aggregates these values in the ratio (page 969) value. If the ratio (page 969) value is small but totalTime (page 968) is

high the globalLock (page 968) has typically been held frequently for shorter periods of time, which may be indicative of a more normal use pattern. If the lockTime (page 968) is higher and the totalTime (page 968) is smaller (relatively,) then fewer operations are responsible for a greater portion of server's use (relatively.)

serverStatus.globalLock.**ratio**
Changed in version 2.2: ratio (page 969) was removed. See locks (page 966). The value of ratio (page 969) displays the relationship between lockTime (page 968) and totalTime (page 968).

Low values indicate that operations have held the globalLock (page 968) frequently for shorter periods of time. High values indicate that operations have held globalLock (page 968) infrequently for longer periods of time.

globalLock.currentQueue

serverStatus.globalLock.**currentQueue**
The currentQueue (page 969) data structure value provides more granular information concerning the number of operations queued because of a lock.

serverStatus.globalLock.currentQueue.**total**
The value of total (page 969) provides a combined total of operations queued waiting for the lock.

A consistently small queue, particularly of shorter operations should cause no concern. Also, consider this value in light of the size of queue waiting for the read lock (e.g. readers (page 969)) and write-lock (e.g. writers (page 969)) individually.

serverStatus.globalLock.currentQueue.**readers**
The value of readers (page 969) is the number of operations that are currently queued and waiting for the read-lock. A consistently small read-queue, particularly of shorter operations should cause no concern.

serverStatus.globalLock.currentQueue.**writers**
The value of writers (page 969) is the number of operations that are currently queued and waiting for the write-lock. A consistently small write-queue, particularly of shorter operations is no cause for concern.

globalLock.activeClients

serverStatus.globalLock.**activeClients**
The activeClients (page 969) data structure provides more granular information about the number of connected clients and the operation types (e.g. read or write) performed by these clients.

Use this data to provide context for the *currentQueue* (page 969) data.

serverStatus.globalLock.activeClients.**total**
The value of total (page 969) is the total number of active client connections to the database. This combines clients that are performing read operations (e.g. readers (page 969)) and clients that are performing write operations (e.g. writers (page 969)).

serverStatus.globalLock.activeClients.**readers**
The value of readers (page 969) contains a count of the active client connections performing read operations.

serverStatus.globalLock.activeClients.**writers**
The value of writers (page 969) contains a count of active client connections performing write operations.

63.2.4 mem

Example

output of the memory fields (page 962).

`serverStatus.`**`mem`**
The `mem` (page 970) data structure holds information regarding the target system architecture of `mongod` (page 897) and current memory use.

`serverStatus.mem.`**`bits`**
The value of `bits` (page 970) is either `64` or `32`, depending on which target architecture specified during the `mongod` (page 897) compilation process. In most instances this is `64`, and this value does not change over time.

`serverStatus.mem.`**`resident`**
The value of `resident` (page 970) is roughly equivalent to the amount of RAM, in megabytes (MB), currently used by the database process. In normal use this value tends to grow. In dedicated database servers this number tends to approach the total amount of system memory.

`serverStatus.mem.`**`virtual`**
`virtual` (page 970) displays the quantity, in megabytes (MB), of virtual memory used by the `mongod` (page 897) process. In typical deployments this value is slightly larger than `mapped` (page 970). If this value is significantly (i.e. gigabytes) larger than `mapped` (page 970), this could indicate a memory leak.

With *journaling* enabled, the value of `virtual` (page 970) is twice the value of `mapped` (page 970).

`serverStatus.mem.`**`supported`**
`supported` (page 970) is true when the underlying system supports extended memory information. If this value is false and the system does not support extended memory information, then other `mem` (page 970) values may not be accessible to the database server.

`serverStatus.mem.`**`mapped`**
The value of `mapped` (page 970) provides the amount of mapped memory, in megabytes (MB), by the database. Because MongoDB uses memory-mapped files, this value is likely to be to be roughly equivalent to the total size of your database or databases.

`serverStatus.mem.`**`mappedWithJournal`**
`mappedWithJournal` (page 970) provides the amount of mapped memory, in megabytes (MB), including the memory used for journaling. This value will always be twice the value of `mapped` (page 970). This field is only included if journaling is enabled.

63.2.5 connections

Example

output of the connections fields (page 963).

`serverStatus.`**`connections`**
The `connections` (page 970) sub document data regarding the current connection status and availability of the database server. Use these values to asses the current load and capacity requirements of the server.

`serverStatus.connections.`**`current`**
The value of `current` (page 970) corresponds to the number of connections to the database server from clients. This number includes the current shell session. Consider the value of `available` (page 970) to add more context to this datum.

This figure will include the current shell connection as well as any inter-node connections to support a *replica set* or *sharded cluster*.

`serverStatus.connections.`**`available`**
`available` (page 970) provides a count of the number of unused available connections that the database

can provide. Consider this value in combination with the value of `current` (page 970) to understand the connection load on the database, and the *Linux ulimit Settings* (page 71) document for more information about system thresholds on available connections.

63.2.6 extra_info

Example

output of the extra_info fields (page 963).

`serverStatus.`**`extra_info`**
The `extra_info` (page 971) data structure holds data collected by the `mongod` (page 897) instance about the underlying system. Your system may only report a subset of these fields.

`serverStatus.extra_info.`**`note`**
The field `note` (page 971) reports that the data in this structure depend on the underlying platform, and has the text: "fields vary by platform."

`serverStatus.extra_info.`**`heap_usage_bytes`**
The `heap_usage_bytes` (page 971) field is only available on Unix/Linux systems, and reports the total size in bytes of heap space used by the database process.

`serverStatus.extra_info.`**`page_faults`**
The `page_faults` (page 971) field is only available on Unix/Linux systems, and reports the total number of page faults that require disk operations. Page faults refer to operations that require the database server to access data which isn't available in active memory. The `page_faults` counter may increase dramatically during moments of poor performance and may correlate with limited memory environments and larger data sets. Limited and sporadic page faults do not necessarily indicate an issue.

63.2.7 indexCounters

Example

output of the indexCounters fields (page 963).

`serverStatus.`**`indexCounters`**
Changed in version 2.2: Previously, data in the `indexCounters` (page 971) document reported sampled data, and were only useful in relative comparison to each other, because they could not reflect absolute index use. In 2.2 and later, these data reflect actual index use. The `indexCounters` (page 971) data structure reports information regarding the state and use of indexes in MongoDB.

`serverStatus.indexCounters.`**`btree`**
The `btree` (page 971) data structure contains data regarding MongoDB's *btree* indexes.

`serverStatus.indexCounters.btree.`**`accesses`**
`accesses` (page 971) reports the number of times that operations have accessed indexes. This value is the combination of the `hits` (page 971) and `misses` (page 972). Higher values indicate that your database has indexes and that queries are taking advantage of these indexes. If this number does not grow over time, this might indicate that your indexes do not effectively support your use.

`serverStatus.indexCounters.btree.`**`hits`**
The `hits` (page 971) value reflects the number of times that an index has been accessed and `mongod` (page 897) is able to return the index from memory.

A higher value indicates effective index use. `hits` (page 971) values that represent a greater proportion of the `accesses` (page 971) value, tend to indicate more effective index configuration.

`serverStatus.indexCounters.btree.`**`misses`**
The `misses` (page 972) value represents the number of times that an operation attempted to access an index that was not in memory. These "misses," do not indicate a failed query or operation, but rather an inefficient use of the index. Lower values in this field indicate better index use and likely overall performance as well.

`serverStatus.indexCounters.btree.`**`resets`**
The `resets` (page 972) value reflects the number of times that the index counters have been reset since the database last restarted. Typically this value is `0`, but use this value to provide context for the data specified by other `indexCounters` (page 971) values.

`serverStatus.indexCounters.btree.`**`missRatio`**
The `missRatio` (page 972) value is the ratio of `hits` (page 971) to `misses` (page 972) misses. This value is typically `0` or approaching `0`.

63.2.8 backgroundFlushing

Example

output of the backgroundFlushing fields (page 963).

`serverStatus.`**`backgroundFlushing`**
`mongod` (page 897) periodically flushes writes to disk. In the default configuration, this happens every 60 seconds. The `backgroundFlushing` (page 972) data structure contains data regarding these operations. Consider these values if you have concerns about write performance and *journaling* (page 977).

`serverStatus.backgroundFlushing.`**`flushes`**
`flushes` (page 972) is a counter that collects the number of times the database has flushed all writes to disk. This value will grow as database runs for longer periods of time.

`serverStatus.backgroundFlushing.`**`total_ms`**
The `total_ms` (page 972) value provides the total number of milliseconds (ms) that the `mongod` (page 897) processes have spent writing (i.e. flushing) data to disk. Because this is an absolute value, consider the value of `flushes` (page 972) and `average_ms` (page 972) to provide better context for this datum.

`serverStatus.backgroundFlushing.`**`average_ms`**
The `average_ms` (page 972) value describes the relationship between the number of flushes and the total amount of time that the database has spent writing data to disk. The larger `flushes` (page 972) is, the more likely this value is likely to represent a "normal," time; however, abnormal data can skew this value.

Use the `last_ms` (page 972) to ensure that a high average is not skewed by transient historical issue or a random write distribution.

`serverStatus.backgroundFlushing.`**`last_ms`**
The value of the `last_ms` (page 972) field is the amount of time, in milliseconds, that the last flush operation took to complete. Use this value to verify that the current performance of the server and is in line with the historical data provided by `average_ms` (page 972) and `total_ms` (page 972).

`serverStatus.backgroundFlushing.`**`last_finished`**
The `last_finished` (page 972) field provides a timestamp of the last completed flush operation in the *ISODate* format. If this value is more than a few minutes old relative to your server's current time and accounting for differences in time zone, restarting the database may result in some data loss.

Also consider ongoing operations that might skew this value by routinely block write operations.

63.2.9 cursors

Example

output of the cursors (page 963) fields.

`serverStatus.`**`cursors`**
The `cursors` (page 973) data structure contains data regarding cursor state and use.

`serverStatus.cursors.`**`totalOpen`**
`totalOpen` (page 973) provides the number of cursors that MongoDB is maintaining for clients. Because MongoDB exhausts unused cursors, typically this value small or zero. However, if there is a queue, stale tailable cursors, or a large number of operations this value may rise.

`serverStatus.cursors.`**`clientCursors_size`**
Deprecated since version 1.x: See `totalOpen` (page 973) for this datum.

`serverStatus.cursors.`**`timedOut`**
`timedOut` (page 973) provides a counter of the total number of cursors that have timed out since the server process started. If this number is large or growing at a regular rate, this may indicate an application error.

63.2.10 network

Example

output of the network fields (page 963).

`serverStatus.`**`network`**
The `network` (page 973) data structure contains data regarding MongoDB's network use.

`serverStatus.network.`**`bytesIn`**
The value of the `bytesIn` (page 973) field reflects the amount of network traffic, in bytes, received *by* this database. Use this value to ensure that network traffic sent to the `mongod` (page 897) process is consistent with expectations and overall inter-application traffic.

`serverStatus.network.`**`bytesOut`**
The value of the `bytesOut` (page 973) field reflects the amount of network traffic, in bytes, sent *from* this database. Use this value to ensure that network traffic sent by the `mongod` (page 897) process is consistent with expectations and overall inter-application traffic.

`serverStatus.network.`**`numRequests`**
The `numRequests` (page 973) field is a counter of the total number of distinct requests that the server has received. Use this value to provide context for the `bytesIn` (page 973) and `bytesOut` (page 973) values to ensure that MongoDB's network utilization is consistent with expectations and application use.

63.2.11 repl

Example

output of the repl fields (page 963).

serverStatus.**repl**
: The repl (page 973) data structure contains status information for MongoDB's replication (i.e. "replica set") configuration. These values only appear when the current host has replication enabled.

  See *Replica Set Fundamental Concepts* (page 279) for more information on replication.

serverStatus.repl.**setName**
: The setName (page 974) field contains a string with the name of the current replica set. This value reflects the *--replSet* (page 903) command line argument, or replSet (page 952) value in the configuration file.

  See *Replica Set Fundamental Concepts* (page 279) for more information on replication.

serverStatus.repl.**ismaster**
: The value of the ismaster (page 974) field is either true or false and reflects whether the current node is the master or primary node in the replica set.

  See *Replica Set Fundamental Concepts* (page 279) for more information on replication.

serverStatus.repl.**secondary**
: The value of the secondary (page 974) field is either true or false and reflects whether the current node is a secondary node in the replica set.

  See *Replica Set Fundamental Concepts* (page 279) for more information on replication.

serverStatus.repl.**hosts**
: hosts (page 974) is an array that lists the other nodes in the current replica set. Each member of the replica set appears in the form of hostname:port.

  See *Replica Set Fundamental Concepts* (page 279) for more information on replication.

63.2.12 opcountersRepl

Example

output of the opcountersRepl fields (page 964).

serverStatus.**opcountersRepl**
: The opcountersRepl (page 974) data structure, similar to the opcounters (page 975) data structure, provides an overview of database replication operations by type and makes it possible to analyze the load on the replica in more granular manner. These values only appear when the current host has replication enabled.

  These values will differ from the opcounters (page 975) values because of how MongoDB serializes operations during replication. See *Replica Set Fundamental Concepts* (page 279) for more information on replication.

  These numbers will grow over time in response to database use. Analyze these values over time to track database utilization.

serverStatus.opcountersRepl.**insert**
: insert (page 974) provides a counter of the total number of replicated insert operations since the mongod (page 897) instance last started.

serverStatus.opcountersRepl.**query**
: query (page 974) provides a counter of the total number of replicated queries since the mongod (page 897) instance last started.

serverStatus.opcountersRepl.**update**
: update (page 974) provides a counter of the total number of replicated update operations since the mongod (page 897) instance last started.

serverStatus.opcountersRepl.**delete**
: delete (page 974) provides a counter of the total number of replicated delete operations since the mongod (page 897) instance last started.

serverStatus.opcountersRepl.**getmore**
: getmore (page 975) provides a counter of the total number of "getmore" operations since the mongod (page 897) instance last started. This counter can be high even if the query count is low. Secondary nodes send getMore operations as part of the replication process.

serverStatus.opcountersRepl.**command**
: command (page 975) provides a counter of the total number of replicated commands issued to the database since the mongod (page 897) instance last started.

63.2.13 replNetworkQueue

New in version 2.1.2.

Example

output of the replNetworkQueue fields (page 964).

---

serverStatus.**replNetworkQueue**
: The replNetworkQueue (page 975) document reports on the network replication buffer, which permits replication operations to happen in the background. This feature is internal.

  This document only appears on *secondary* members of *replica sets*.

serverStatus.replNetworkQueue.**waitTimeMs**
: waitTimeMs (page 975) reports the amount of time that a *secondary* waits to add operations to network queue. This value is cumulative.

serverStatus.replNetworkQueue.**numElems**
: numElems (page 975) reports the number of operations stored in the queue.

serverStatus.replNetworkQueue.**numBytes**
: numBytes (page 975) reports the total size of the network replication queue.

63.2.14 opcounters

Example

output of the opcounters fields (page 964).

---

serverStatus.**opcounters**
: The opcounters (page 975) data structure provides an overview of database operations by type and makes it possible to analyze the load on the database in more granular manner.

  These numbers will grow over time and in response to database use. Analyze these values over time to track database utilization.

serverStatus.opcounters.**insert**
: insert (page 975) provides a counter of the total number of insert operations since the mongod (page 897) instance last started.

serverStatus.opcounters.**query**
: query (page 975) provides a counter of the total number of queries since the mongod (page 897) instance last started.

serverStatus.opcounters.**update**
: update (page 976) provides a counter of the total number of update operations since the mongod (page 897) instance last started.

serverStatus.opcounters.**delete**
: delete (page 976) provides a counter of the total number of delete operations since the mongod (page 897) instance last started.

serverStatus.opcounters.**getmore**
: getmore (page 976) provides a counter of the total number of "getmore" operations since the mongod (page 897) instance last started. This counter can be high even if the query count is low. Secondary nodes send getMore operations as part of the replication process.

serverStatus.opcounters.**command**
: command (page 976) provides a counter of the total number of commands issued to the database since the mongod (page 897) instance last started.

63.2.15 asserts

Example

output of the asserts fields (page 964).

serverStatus.**asserts**
: The asserts (page 976) document reports the number of asserts on the database. While assert errors are typically uncommon, if there are non-zero values for the asserts (page 976), you should check the log file for the mongod (page 897) process for more information. In many cases these errors are trivial, but are worth investigating.

serverStatus.asserts.**regular**
: The regular (page 976) counter tracks the number of regular assertions raised since the server process started. Check the log file for more information about these messages.

serverStatus.asserts.**warning**
: The warning (page 976) counter tracks the number of warnings raised since the server process started. Check the log file for more information about these warnings.

serverStatus.asserts.**msg**
: The msg (page 976) counter tracks the number of message assertions raised since the server process started. Check the log file for more information about these messages.

serverStatus.asserts.**user**
: The user (page 976) counter reports the number of "user asserts" that have occurred since the last time the server process started. These are errors that user may generate, such as out of disk space or duplicate key. You can prevent these assertions by fixing a problem with your application or deployment. Check the MongoDB log for more information.

serverStatus.asserts.**rollovers**
: The rollovers (page 976) counter displays the number of times that the rollover counters have rolled over since the last time the server process started. The counters will rollover to zero after 2^{30} assertions. Use this value to provide context to the other values in the asserts (page 976) data structure.

63.2.16 writeBacksQueued

Example

output of the writeBacksQueued fields (page 964).

`serverStatus.`**`writeBacksQueued`**
The value of `writeBacksQueued` (page 977) is `true` when there are operations from a `mongos` (page 905) instance queued for retrying. Typically this option is false.

See Also:

writeBacks

63.2.17 dur

New in version 1.8.

Journaling

Example

output of the journaling fields (page 964).

`serverStatus.`**`dur`**
The `dur` (page 977) (for "durability") document contains data regarding the `mongod` (page 897)'s journaling-related operations and performance. `mongod` (page 897) must be running with journaling for these data to appear in the output of "`serverStatus` (page 792)".

Note: The data values are **not** cumulative but are reset on a regular basis as determined by the *journal group commit interval* (page 43). This interval is ~100 milliseconds (ms) by default (or 30ms if the journal file is on the same file system as your data files) and is cut by 1/3 when there is a `getLastError` (page 766) command pending. The interval is configurable using the `--journalCommitInterval` option.

See Also:

"*Journaling* (page 41)" for more information about journaling operations.

`serverStatus.dur.`**`commits`**
The `commits` (page 977) provides the number of transactions written to the *journal* during the last *journal group commit interval* (page 43).

`serverStatus.dur.`**`journaledMB`**
The `journaledMB` (page 977) provides the amount of data in megabytes (MB) written to *journal* during the last *journal group commit interval* (page 44).

`serverStatus.dur.`**`writeToDataFilesMB`**
The `writeToDataFilesMB` (page 977) provides the amount of data in megabytes (MB) written from *journal* to the data files during the last *journal group commit interval* (page 44).

`serverStatus.dur.`**`compression`**
New in version 2.0. The `compression` (page 977) represents the compression ratio of the data written to the *journal*:

```
( journaled_size_of_data / uncompressed_size_of_data )
```

`serverStatus.dur.`**`commitsInWriteLock`**
The `commitsInWriteLock` (page 978) provides a count of the commits that occurred while a write lock was held. Commits in a write lock indicate a MongoDB node under a heavy write load and call for further diagnosis.

`serverStatus.dur.`**`earlyCommits`**
The `earlyCommits` (page 978) value reflects the number of times MongoDB requested a commit before the scheduled *journal group commit interval* (page 44). Use this value to ensure that your *journal group commit interval* (page 43) is not too long for your deployment.

`serverStatus.dur.`**`timeMS`**
The `timeMS` (page 978) document provides information about the performance of the `mongod` (page 897) instance during the various phases of journaling in the last *journal group commit interval* (page 43).

`serverStatus.dur.timeMS.`**`dt`**
The `dt` (page 978) value provides, in milliseconds, the amount of time over which MongoDB collected the `timeMS` (page 978) data. Use this field to provide context to the other `timeMS` (page 978) field values.

`serverStatus.dur.timeMS.`**`prepLogBuffer`**
The `prepLogBuffer` (page 978) value provides, in milliseconds, the amount of time spent preparing to write to the journal. Smaller values indicate better journal performance.

`serverStatus.dur.timeMS.`**`writeToJournal`**
The `writeToJournal` (page 978) value provides, in milliseconds, the amount of time spent actually writing to the journal. File system speeds and device interfaces can affect performance.

`serverStatus.dur.timeMS.`**`writeToDataFiles`**
The `writeToDataFiles` (page 978) value provides, in milliseconds, the amount of time spent writing to data files after journaling. File system speeds and device interfaces can affect performance.

`serverStatus.dur.timeMS.`**`remapPrivateView`**
The `remapPrivateView` (page 978) value provides, in milliseconds, the amount of time spent remapping copy-on-write memory mapped views. Smaller values indicate better journal performance.

63.2.18 recordStats

Example

output of the recordStats (page 965) fields.

`serverStatus.`**`recordStats`**
The `recordStats` (page 978) document provides fine grained reporting on page faults on a per database level.

`serverStatus.recordStats.`**`accessesNotInMemory`**
`accessesNotInMemory` (page 978) reflects the number of times `mongod` (page 897) needed to access a memory page that was *not* resident in memory for *all* databases managed by this `mongod` (page 897) instance.

`serverStatus.recordStats.`**`pageFaultExceptionsThrown`**
`pageFaultExceptionsThrown` (page 978) reflects the number of page fault exceptions thrown by `mongod` (page 897) when accessing data for *all* databases managed by this `mongod` (page 897) instance.

`serverStatus.recordStats.local.`**`accessesNotInMemory`**
`accessesNotInMemory` (page 978) reflects the number of times `mongod` (page 897) needed to access a memory page that was *not* resident in memory for the `local` database.

serverStatus.recordStats.local.**pageFaultExceptionsThrown**
: pageFaultExceptionsThrown (page 978) reflects the number of page fault exceptions thrown by mongod (page 897) when accessing data for the local database.

serverStatus.recordStats.admin.**accessesNotInMemory**
: accessesNotInMemory (page 979) reflects the number of times mongod (page 897) needed to access a memory page that was *not* resident in memory for the *admin database*.

serverStatus.recordStats.admin.**pageFaultExceptionsThrown**
: pageFaultExceptionsThrown (page 979) reflects the number of page fault exceptions thrown by mongod (page 897) when accessing data for the *admin database*.

serverStatus.recordStats.<database>.**accessesNotInMemory**
: accessesNotInMemory (page 979) reflects the number of times mongod (page 897) needed to access a memory page that was *not* resident in memory for the <database> database.

serverStatus.recordStats.<database>.**pageFaultExceptionsThrown**
: pageFaultExceptionsThrown (page 979) reflects the number of page fault exceptions thrown by mongod (page 897) when accessing data for the <database> database.

63.3 Database Statistics Reference

63.3.1 Synopsis

MongoDB can report data that reflects the current state of the "active" database. In this context "database," refers to a single MongoDB database. To run dbStats (page 753) issue this command in the shell:

```
db.runCommand( { dbStats: 1 } )
```

The mongo (page 908) shell provides the helper function db.stats() (page 855). Use the following form:

```
db.stats()
```

The above commands are equivalent. Without any arguments, db.stats() (page 855) returns values in bytes. To convert the returned values to kilobytes, use the scale argument:

```
db.stats(1024)
```

Or:

```
db.runCommand( { dbStats: 1, scale: 1024 } )
```

Note: Because scaling rounds values to whole numbers, scaling may return unlikely or unexpected results.

The above commands are equivalent. See the dbStats (page 753) *database command* and the db.stats() (page 855) helper for the mongo (page 908) shell for additional information.

63.3.2 Fields

dbStats.**db**
: Contains the name of the database.

dbStats.**collections**
: Contains a count of the number of collections in that database.

dbStats.**objects**
Contains a count of the number of objects (i.e. *documents*) in the database across all collections.

dbStats.**avgObjSize**
The average size of each document in bytes. This is the dataSize (page 980) divided by the number of documents.

dbStats.**dataSize**
The total size of the data held in this database including the *padding factor*. The scale argument affects this value. The dataSize (page 980) will not decrease when *documents* shrink, but will decrease when you remove documents.

dbStats.**storageSize**
The total amount of space allocated to collections in this database for *document* storage. The scale argument affects this value. The storageSize (page 980) does not decrease as you remove or shrink documents.

dbStats.**numExtents**
Contains a count of the number of extents in the database across all collections.

dbStats.**indexes**
Contains a count of the total number of indexes across all collections in the database.

dbStats.**indexSize**
The total size of all indexes created on this database. The scale arguments affects this value.

dbStats.**fileSize**
The total size of the data files that hold the database. This value includes preallocated space and the *padding factor*. The value of fileSize (page 980) only reflects the size of the data files for the database and not the namespace file.

The scale argument affects this value.

dbStats.**nsSizeMB**
The total size of the *namespace* files (i.e. that end with .ns) for this database. You cannot change the size of the namespace file after creating a database, but you can change the default size for all new namespace files with the nssize (page 949) runtime option.

See Also:

The nssize (page 949) option, and *Maximum Namespace File Size* (page 1021)

63.4 Collection Statistics Reference

63.4.1 Synopsis

To fetch collection statistics, call the db.collection.stats() (page 841) method on a collection object in the mongo (page 908) shell:

```
db.collection.stats()
```

You may also use the literal command format:

```
db.runCommand( { collStats: "collection" } )
```

Replace collection in both examples with the name of the collection you want statistics for. By default, the return values will appear in terms of bytes. You can, however, enter a scale argument. For example, you can convert the return values to kilobytes like so:

```
db.collection.stats(1024)
```

Or:

```
db.runCommand( { collStats: "collection", scale: 1024 } )
```

Note: The `scale` argument rounds values to whole numbers. This can produce unpredictable and unexpected results in some situations.

See Also:

The documentation of the "`collStats` (page 745)" command and the "`db.collection.stats()` (page 841)," method in the `mongo` (page 908) shell.

63.4.2 Example Document

The output of `db.collection.stats()` (page 841) resembles the following:

```
{
     "ns" : "<database>.<collection>",
     "count" : <number>,
     "size" : <number>,
     "avgObjSize" : <number>,
     "storageSize" : <number>,
     "numExtents" : <number>,
     "nindexes" : <number>,
     "lastExtentSize" : <number>,
     "paddingFactor" : <number>,
     "systemFlags" : <bit>,
     "userFlags" : <bit>,
     "totalIndexSize" : <number>,
     "indexSizes" : {
             "_id_" : <number>,
             "a_1" : <number>
     },
     "ok" : 1
}
```

63.4.3 Fields

`collStats.`**`ns`**
The namespace of the current collection, which follows the format `[database].[collection]`.

`collStats.`**`count`**
The number of objects or documents in this collection.

`collStats.`**`size`**
The size of the data stored in this collection. This value does not include the size of any indexes associated with the collection, which the `totalIndexSize` (page 982) field reports.

The `scale` argument affects this value.

`collStats.`**`avgObjSize`**
The average size of an object in the collection. The `scale` argument affects this value.

collStats.**storageSize**
The total amount of storage allocated to this collection for *document* storage. The scale argument affects this value. The storageSize (page 981) does not decrease as you remove or shrink documents.

collStats.**numExtents**
The total number of contiguously allocated data file regions.

collStats.**nindexes**
The number of indexes on the collection. All collections have at least one index on the *_id* field. Changed in version 2.2: Before 2.2, capped collections did not necessarily have an index on the _id field, and some capped collections created with pre-2.2 versions of mongod (page 897) may not have an _id index.

collStats.**lastExtentSize**
The size of the last extent allocated. The scale argument affects this value.

collStats.**paddingFactor**
The amount of space added to the end of each document at insert time. The document padding provides a small amount of extra space on disk to allow a document to grow slightly without needing to move the document. mongod (page 897) automatically calculates this padding factor

collStats.**flags**
Changed in version 2.2: Removed in version 2.2 and replaced with the userFlags (page 982) and systemFlags (page 982) fields. Indicates the number of flags on the current collection. In version 2.0, the only flag notes the existence of an *index* on the *_id* field.

collStats.**systemFlags**
New in version 2.2. Reports the flags on this collection that reflect internal server options. Typically this value is 1 and reflects the existence of an *index* on the _id field.

collStats.**userFlags**
New in version 2.2. Reports the flags on this collection set by the user. In version 2.2 the only user flag is usePowerOf2Sizes (page 744). If usePowerOf2Sizes (page 744) is enabled, userFlags (page 982) will be set to 1, otherwise userFlags (page 982) will be 0.

See the collMod (page 744) command for more information on setting user flags and usePowerOf2Sizes (page 744).

collStats.**totalIndexSize**
The total size of all indexes. The scale argument affects this value.

collStats.**indexSizes**
This field specifies the key and size of every existing index on the collection. The scale argument affects this value.

63.5 Collection Validation Data

63.5.1 Synopsis

The collection validation command checks all of the structures within a name space for correctness and returns a *document* containing information regarding the on-disk representation of the collection.

Warning: The validate (page 799) process may consume significant system resources and impede application performance because it must scan all data in the collection.

Run the validation command in the mongo (page 908) shell using the following form to validate a collection named people:

```
db.people.validate()
```

Alternatively you can use the command prototype and the db.runCommand() (page 853) shell helper in the following form:

```
db.runCommand( { validate: "people", full: true } )
db.people.validate(true)
```

See Also:

validate (page 799) and validate() (page 844).

63.5.2 Values

validate.**ns**
: The full namespace name of the collection. Namespaces include the database name and the collection name in the form database.collection.

validate.**firstExtent**
: The disk location of the first extent in the collection. The value of this field also includes the namespace.

validate.**lastExtent**
: The disk location of the last extent in the collection. The value of this field also includes the namespace.

validate.**extentCount**
: The number of extents in the collection.

validate.**extents**
: validate (page 799) returns one instance of this document for every extent in the collection. This subdocument is only returned when you specify the full option to the command.

  validate.extents.**loc**
  : The disk location for the beginning of this extent.

  validate.extents.**xnext**
  : The disk location for the extent following this one. "null" if this is the end of the linked list of extents.

  validate.extents.**xprev**
  : The disk location for the extent preceding this one. "null" if this is the head of the linked list of extents.

  validate.extents.**nsdiag**
  : The namespace this extent belongs to (should be the same as the namespace shown at the beginning of the validate listing).

  validate.extents.**size**
  : The number of bytes in this extent.

  validate.extents.**firstRecord**
  : The disk location of the first record in this extent.

  validate.extents.**lastRecord**
  : The disk location of the last record in this extent.

validate.**datasize**
: The number of bytes in all data records. This value does not include deleted records, nor does it include extent headers, nor record headers, nor space in a file unallocated to any extent. datasize (page 983) includes record *padding*.

validate.**nrecords**
: The number of *documents* in the collection.

validate.**lastExtentSize**
The size of the last new extent created in this collection. This value determines the size of the *next* extent created.

validate.**padding**
A floating point value between 1 and 2.

When MongoDB creates a new record it uses the *padding factor* to determine how much additional space to add to the record. The padding factor is automatically adjusted by mongo when it notices that update operations are triggering record moves.

validate.**firstExtentDetails**
The size of the first extent created in this collection. This data is similar to the data provided by the extents (page 983) sub-document; however, the data reflects only the first extent in the collection and is always returned.

validate.firstExtentDetails.**loc**
The disk location for the beginning of this extent.

validate.firstExtentDetails.**xnext**
The disk location for the extent following this one. "null" if this is the end of the linked list of extents, which should only be the case if there is only one extent.

validate.firstExtentDetails.**xprev**
The disk location for the extent preceding this one. This should always be "null."

validate.firstExtentDetails.**nsdiag**
The namespace this extent belongs to (should be the same as the namespace shown at the beginning of the validate listing).

validate.firstExtentDetails.**size**
The number of bytes in this extent.

validate.firstExtentDetails.**firstRecord**
The disk location of the first record in this extent.

validate.firstExtentDetails.**lastRecord**
The disk location of the last record in this extent.

validate.**objectsFound**
The number of records actually encountered in a scan of the collection. This field should have the same value as the nrecords (page 983) field.

validate.**invalidObjects**
The number of records containing BSON documents that do not pass a validation check.

Note: This field is only included in the validation output when you specify the full option.

---

validate.**bytesWithHeaders**
This is similar to datasize, except that bytesWithHeaders (page 984) includes the record headers. In version 2.0, record headers are 16 bytes per document.

Note: This field is only included in the validation output when you specify the full option.

---

validate.**bytesWithoutHeaders**
bytesWithoutHeaders (page 984) returns data collected from a scan of all records. The value should be the same as datasize (page 983).

Note: This field is only included in the validation output when you specify the full option.

validate.**deletedCount**
The number of deleted or "free" records in the collection.

validate.**deletedSize**
The size of all deleted or "free" records in the collection.

validate.**nIndexes**
The number of indexes on the data in the collection.

validate.**keysPerIndex**
A document containing a field for each index, named after the index's name, that contains the number of keys, or documents referenced, included in the index.

validate.**valid**
Boolean. `true`, unless `validate` (page 799) determines that an aspect of the collection is not valid. When `false`, see the `errors` (page 985) field for more information.

validate.**errors**
Typically empty; however, if the collection is not valid (i.e `valid` (page 985) is false,) this field will contain a message describing the validation error.

validate.**ok**
Set to `1` when the command succeeds. If the command fails the `ok` (page 985) field has a value of `0`.

63.6 Connection Pool Statistics Reference

63.6.1 Synopsis

`mongos` (page 905) instances maintain a pool of connections for interacting with constituent members of the *sharded cluster*. Additionally, `mongod` (page 897) instances maintain connection with other shards in the cluster for migrations. The `connPoolStats` (page 748) command returns statistics regarding these connections between the `mongos` (page 905) and `mongod` (page 897) instances or between the `mongod` (page 897) instances in a shard cluster.

Note: `connPoolStats` (page 748) only returns meaningful results for `mongos` (page 905) instances and for `mongod` (page 897) instances in sharded clusters.

63.6.2 Output

connPoolStats.**hosts**
The sub-documents of the `hosts` (page 985) *document* report connections between the `mongos` (page 905) or `mongod` (page 897) instance and each component `mongod` (page 897) of the *sharded cluster*.

connPoolStats.hosts.[host].**available**
`available` (page 985) reports the total number of connections that the `mongos` (page 905) or `mongod` (page 897) could use to connect to this `mongod` (page 897).

connPoolStats.hosts.[host].**created**
`created` (page 985) reports the number of connections that this `mongos` (page 905) or `mongod` (page 897) has ever created for this host.

connPoolStats.**replicaSets**
`replicaSets` (page 985) is a *document* that contains *replica set* information for the *sharded cluster*.

connPoolStats.replicaSets.**shard**
The shard (page 985) *document* reports on each *shard* within the *sharded cluster*

connPoolStats.replicaSets.[shard].**host**
The host (page 986) field holds an array of *document* that reports on each host within the *shard* in the *replica set*.

These values derive from the *replica set status* (page 987) values.

connPoolStats.replicaSets.[shard].host[n].**addr**
addr (page 986) reports the address for the host in the *sharded cluster* in the format of "[hostname]:[port]".

connPoolStats.replicaSets.[shard].host[n].**ok**
ok (page 986) reports false when:
- the mongos (page 905) or mongod (page 897) cannot connect to instance.
- the mongos (page 905) or mongod (page 897) received a connection exception or error.

This field is for internal use.

connPoolStats.replicaSets.[shard].host[n].**ismaster**
ismaster (page 986) reports true if this host (page 986) is the *primary* member of the *replica set*.

connPoolStats.replicaSets.[shard].host[n].**hidden**
hidden (page 986) reports true if this host (page 986) is a *hidden member* of the *replica set*.

connPoolStats.replicaSets.[shard].host[n].**secondary**
secondary (page 986) reports true if this host (page 986) is a *secondary* member of the *replica set*.

connPoolStats.replicaSets.[shard].host[n].**pingTimeMillis**
pingTimeMillis (page 986) reports the ping time in milliseconds from the mongos (page 905) or mongod (page 897) to this host (page 986).

connPoolStats.replicaSets.[shard].host[n].**tags**
New in version 2.2. tags (page 986) reports the tags (page 991), if this member of the set has tags configured.

connPoolStats.replicaSets.[shard].**master**
master (page 986) reports the ordinal identifier of the host in the host (page 986) array that is the *primary* of the *replica set*.

connPoolStats.replicaSets.[shard].**nextSlave**
Deprecated since version 2.2. nextSlave (page 986) reports the *secondary* member that the mongos (page 905) will use to service the next request for this *replica set*.

connPoolStats.**createdByType**
createdByType (page 986) *document* reports the number of each type of connection that mongos (page 905) or mongod (page 897) has created in all connection pools.

mongos (page 905) connect to mongod (page 897) instances using one of three types of connections. The following sub-document reports the total number of connections by type.

connPoolStats.createdByType.**master**
master (page 986) reports the total number of connections to the *primary* member in each *cluster*.

connPoolStats.createdByType.**set**
set (page 986) reports the total number of connections to a *replica set* member.

connPoolStats.createdByType.**sync**
sync (page 986) reports the total number of *config database* connections.

connPoolStats.**totalAvailable**
: totalAvailable (page 986) reports the running total of connections from the mongos (page 905) or mongod (page 897) to all mongod (page 897) instances in the *sharded cluster* available for use.

connPoolStats.**totalCreated**
: totalCreated (page 987) reports the total number of connections ever created from the mongos (page 905) or mongod (page 897) to all mongod (page 897) instances in the *sharded cluster*.

connPoolStats.**numDBClientConnection**
: numDBClientConnection (page 987) reports the total number of connections from the mongos (page 905) or mongod (page 897) to all of the mongod (page 897) instances in the *sharded cluster*.

connPoolStats.**numAScopedConnection**
: numAScopedConnection (page 987) reports the number of exception safe connections created from mongos (page 905) or mongod (page 897) to all mongod (page 897) in the *sharded cluster*. The mongos (page 905) or mongod (page 897) releases these connections after receiving a socket exception from the mongod (page 897).

63.7 Replica Set Status Reference

The replSetGetStatus (page 788) provides an overview of the current status of a *replica set*. Issue the following command against the *admin database*, in the mongo (page 908) shell:

```
db.runCommand( { replSetGetStatus: 1 } )
```

You can also use the following helper in the mongo (page 908) shell to access this functionality

```
rs.status()
```

The value specified (e.g 1 above,) does not impact the output of the command. Data provided by this command derives from data included in heartbeats sent to the current instance by other members of the replica set: because of the frequency of heartbeats, these data can be several seconds out of date.

Note: The mongod (page 897) must have replication enabled and be a member of a replica set for the for replSetGetStatus (page 788) to return successfully.

See Also:

"rs.status() (page 861)" shell helper function, "*Replication* (page 277)".

63.7.1 Fields

replSetGetStatus.**set**
: The set value is the name of the replica set, configured in the replSet (page 952) setting. This is the same value as _id (page 989) in rs.conf() (page 859).

replSetGetStatus.**date**
: The value of the date field is an *ISODate* of the current time, according to the current server. Compare this to the value of the lastHeartbeat (page 989) to find the operational lag between the current host and the other hosts in the set.

replSetGetStatus.**myState**
: The value of myState (page 987) reflects state of the current replica set member. An integer between 0 and 10 represents the state of the member. These integers map to states, as described in the following table:

Number	Name	State
0	STARTUP	Start up, phase 1 (parsing configuration.)
1	PRIMARY	Primary.
2	SECONDARY	Secondary.
3	RECOVERING	Member is recovering (initial sync, post-rollback, stale members.)
4	FATAL	Member has encountered an unrecoverable error.
5	STARTUP2	Start up, phase 2 (forking threads.)
6	UNKNOWN	Unknown (the set has never connected to the member.)
7	ARBITER	Member is an *arbiter*.
8	DOWN	Member is not accessible to the set.
9	ROLLBACK	Member is rolling back data. See *rollback*.
10	SHUNNED	Member has been removed from replica set.

`replSetGetStatus.`**`members`**
The `members` field holds an array that contains a document for every member in the replica set. See the "*Member Statuses* (page 988)" for an overview of the values included in these documents.

`replSetGetStatus.`**`syncingTo`**
The `syncingTo` field is only present on the output of `rs.status()` (page 861) on *secondary* and recovering members, and holds the hostname of the member from which this instance is syncing.

63.7.2 Member Statuses

`replSetGetStatus.members.`**`name`**
The `name` field holds the name of the server.

`replSetGetStatus.members.`**`self`**
The `self` field is only included in the document for the current `mongod` instance in the members array. It's value is `true`.

`replSetGetStatus.members.`**`errmsg`**
This field contains the most recent error or status message received from the member. This field may be empty (e.g. `""`) in some cases.

`replSetGetStatus.members.`**`health`**
The `health` value is only present for the other members of the replica set (i.e. not the member that returns `rs.status` (page 861).) This field conveys if the member is up (i.e. `1`) or down (i.e. `0`.)

`replSetGetStatus.members.`**`state`**
The value of the `state` (page 988) reflects state of this replica set member. An integer between `0` and `10` represents the state of the member. These integers map to states, as described in the following table:

Number	Name	State
0	STARTUP	Start up, phase 1 (parsing configuration.)
1	PRIMARY	Primary.
2	SECONDARY	Secondary.
3	RECOVERING	Member is recovering (initial sync, post-rollback, stale members.)
4	FATAL	Member has encountered an unrecoverable error.
5	STARTUP2	Start up, phase 2 (forking threads.)
6	UNKNOWN	Unknown (the set has never connected to the member.)
7	ARBITER	Member is an *arbiter*.
8	DOWN	Member is not accessible to the set.
9	ROLLBACK	Member is rolling back data. See *rollback*.
10	SHUNNED	Member has been removed from replica set.

`replSetGetStatus.members.`**`stateStr`**
A string that describes `state` (page 988).

replSetGetStatus.members.**uptime**
The uptime (page 989) field holds a value that reflects the number of seconds that this member has been online.

This value does not appear for the member that returns the rs.status() (page 861) data.

replSetGetStatus.members.**optime**
A document that contains information regarding the last operation from the operation log that this member has applied.

replSetGetStatus.members.optime.**t**
A 32-bit timestamp of the last operation applied to this member of the replica set from the *oplog*.

replSetGetStatus.members.optime.**i**
An incremented field, which reflects the number of operations in since the last time stamp. This value only increases if there is more than one operation per second.

replSetGetStatus.members.**optimeDate**
An *ISODate* formatted date string that reflects the last entry from the *oplog* that this member applied. If this differs significantly from lastHeartbeat (page 989) this member is either experiencing "replication lag" *or* there have not been any new operations since the last update. Compare members.optimeDate between all of the members of the set.

replSetGetStatus.members.**lastHeartbeat**
The lastHeartbeat value provides an *ISODate* formatted date of the last heartbeat received from this member. Compare this value to the value of the date (page 987) field to track latency between these members.

This value does not appear for the member that returns the rs.status() (page 861) data.

replSetGetStatus.members.**pingMS**
The pingMS represents the number of milliseconds (ms) that a round-trip packet takes to travel between the remote member and the local instance.

This value does not appear for the member that returns the rs.status() (page 861) data.

63.8 Replica Set Configuration

63.8.1 Synopsis

This reference provides an overview of all possible replica set configuration options and settings.

Use rs.conf() (page 859) in the mongo (page 908) shell to retrieve this configuration. Note that default values are not explicitly displayed.

63.8.2 Configuration Variables

local.system.replset.**_id**
Type: string

Value: <setname>

An _id field holding the name of the replica set. This reflects the set name configured with replSet (page 952) or *mongod --replSet* (page 903).

local.system.replset.**members**
Type: array

Contains an array holding an embedded *document* for each member of the replica set. The members document contains a number of fields that describe the configuration of each member of the replica set.

The members (page 989) field in the replica set configuration document is a zero-indexed array.

local.system.replset.members[n].**_id**
Type: ordinal

Provides the zero-indexed identifier of every member in the replica set.

Note: When updating the replica configuration object, address all members of the set using the index value in the array. The array index begins with 0. Do not confuse this index value with the value of the _id (page 990) field in each document in the members (page 989) array.

The _id (page 990) rarely corresponds to the array index.

---

local.system.replset.members[n].**host**
Type: <hostname><:port>

Identifies the host name of the set member with a hostname and port number. This name must be resolvable for every host in the replica set.

Warning: host (page 990) cannot hold a value that resolves to localhost or the local interface unless *all* members of the set are on hosts that resolve to localhost.

local.system.replset.members[n].**arbiterOnly**
Optional.

Type: boolean

Default: false

Identifies an arbiter. For arbiters, this value is true, and is automatically configured by rs.addArb() (page 859)".

local.system.replset.members[n].**buildIndexes**
Optional.

Type: boolean

Default: true

Determines whether the mongod (page 897) builds *indexes* on this member. Do not set to false if a replica set *can* become a master, or if any clients ever issue queries against this instance.

Omitting index creation, and thus this setting, may be useful, **if**:

- You are only using this instance to perform backups using mongodump (page 915),
- this instance will receive no queries, *and*
- index creation and maintenance overburdens the host system.

If set to false, secondaries configured with this option *do* build indexes on the _id field, to facilitate operations required for replication.

Warning: You may only set this value when adding a member to a replica set. You may not reconfigure a replica set to change the value of the buildIndexes (page 990) field after adding the member to the set. Other secondaries cannot replicate from a members where buildIndexes (page 990) is false.

local.system.replset.members[n].**hidden**
Optional.

Type: boolean

Default: false

When this value is `true`, the replica set hides this instance, and does not include the member in the output of `db.isMaster()` (page 850) or `isMaster` (page 772). This prevents read operations (i.e. queries) from ever reaching this host by way of secondary *read preference*.

See Also:

"*Hidden Replica Set Members* (page 287)"

`local.system.replset.members[n].priority`
Optional.

Type: Number, between 0 and 100.0 including decimals.

Default: 1

Specify higher values to make a member *more* eligible to become *primary*, and lower values to make the member *less* eligible to become primary. Priorities are only used in comparison to each other, members of the set will veto elections from members when another eligible member has a higher absolute priority value. Changing the balance of priority in a replica set will cause an election.

A `priority` (page 991) of `0` makes it impossible for a member to become primary.

See Also:

"*Replica Set Member Priority* (page 280)" and "*Replica Set Elections* (page 280)."

`local.system.replset.members[n].tags`
Optional.

Type: *MongoDB Document*

Default: none

Used to represent arbitrary values for describing or tagging members for the purposes of extending *write concern* to allow configurable data center awareness.

Use in conjunction with `getLastErrorModes` (page 992) and `getLastErrorDefaults` (page 992) and `db.getLastError()` (page 849) (i.e. `getLastError` (page 766).)

`local.system.replset.members[n].slaveDelay`
Optional.

Type: Integer. (seconds.)

Default: 0

Describes the number of seconds "behind" the master that this replica set member should "lag." Use this option to create *delayed members* (page 287), that maintain a copy of the data that reflects the state of the data set some amount of time (specified in seconds.) Typically these members help protect against human error, and provide some measure of insurance against the unforeseen consequences of changes and updates.

`local.system.replset.members[n].votes`
Optional.

Type: Integer

Default: 1

Controls the number of votes a server has in a *replica set election* (page 280). The number of votes each member has can be any non-negative integer, but it is highly recommended each member has 1 or 0 votes.

If you need more than 7 members, use this setting to add additional non-voting members with a `votes` (page 991) value of `0`.

For most deployments and most members, use the default value, 1, for votes (page 991).

local.system.replset.**settings**
Optional.

Type: *MongoDB Document*

The settings document configures options that apply to the whole replica set.

local.system.replset.settings.**chainingAllowed**
Optional.

Type: boolean

Default: true New in version 2.2.2. When chainingAllowed (page 992) is true, the replica set allows *secondary* members to replicate from other secondary members. When chainingAllowed (page 992) is false, secondaries can replicate only from the *primary*.

When you run rs.config() (page 859) to view a replica set's configuration, the chainingAllowed (page 992) field appears only when set to false. If not set, chainingAllowed (page 992) is true.

See Also:

Chained Replication (page 289)

local.system.replset.settings.**getLastErrorDefaults**
Optional.

Type: *MongoDB Document*

Specify arguments to the getLastError (page 766) that members of this replica set will use when no arguments to getLastError (page 766) has no arguments. If you specify *any* arguments, getLastError (page 766) , ignores these defaults.

local.system.replset.settings.**getLastErrorModes**
Optional.

Type: *MongoDB Document*

Defines the names and combination of members (page 989) for use by the application layer to guarantee *write concern* to database using the getLastError (page 766) command to provide *data-center awareness*.

63.8.3 Example Document

The following document provides a representation of a replica set configuration document. Angle brackets (e.g. < and >) enclose all optional fields.

```
{
  _id : <setname>,
  version: <int>,
  members: [
    {
      _id : <ordinal>,
      host : hostname<:port>,
      <arbiterOnly : <boolean>,>
      <buildIndexes : <boolean>,>
      <hidden : <boolean>,>
      <priority: <priority>,>
      <tags: { <document> },>
      <slaveDelay : <number>,>
      <votes : <number>>
    }
```

```
    , ...
  ],
  <settings: {
    <getLastErrorDefaults : <lasterrdefaults>,>
    <chainingAllowed : <boolean>,>
    <getLastErrorModes : <modes>>
  }>
}
```

63.8.4 Example Reconfiguration Operations

Most modifications of *replica set* configuration use the `mongo` (page 908) shell. Consider the following reconfiguration operation:

Example

Given the following replica set configuration:

```
{
    "_id" : "rs0",
    "version" : 1,
    "members" : [
            {
                    "_id" : 0,
                    "host" : "mongodb0.example.net:27017"
            },
            {
                    "_id" : 1,
                    "host" : "mongodb1.example.net:27017"
            },
            {
                    "_id" : 2,
                    "host" : "mongodb2.example.net:27017"
            }
     ]
}
```

And the following reconfiguration operation:

```
cfg = rs.conf()
cfg.members[0].priority = 0.5
cfg.members[1].priority = 2
cfg.members[2].priority = 2
rs.reconfig(cfg)
```

This operation begins by saving the current replica set configuration to the local variable `cfg` using the `rs.conf()` (page 859) method. Then it adds priority values to the `cfg` *document* where for the first three sub-documents in the `members` (page 989) array. Finally, it calls the `rs.reconfig()` (page 860) method with the argument of `cfg` to initialize this new configuration. The replica set configuration after this operation will resemble the following:

```
{
    "_id" : "rs0",
    "version" : 1,
    "members" : [
            {
                    "_id" : 0,
                    "host" : "mongodb0.example.net:27017",
```

```
                "priority" : 0.5
        },
        {
                "_id" : 1,
                "host" : "mongodb1.example.net:27017",
                "priority" : 2
        },
        {
                "_id" : 2,
                "host" : "mongodb2.example.net:27017",
                "priority" : 1
        }
    ]
}
```

Using the "dot notation" demonstrated in the above example, you can modify any existing setting or specify any of optional *replica set configuration variables* (page 989). Until you run `rs.reconfig(cfg)` at the shell, no changes will take effect. You can issue `cfg = rs.conf()` at any time before using `rs.reconfig()` (page 860) to undo your changes and start from the current configuration. If you issue `cfg` as an operation at any point, the `mongo` (page 908) shell at any point will output the complete *document* with modifications for your review.

The `rs.reconfig()` (page 860) operation has a "force" option, to make it possible to reconfigure a replica set if a majority of the replica set is not visible, and there is no *primary* member of the set. use the following form:

```
rs.reconfig(cfg, { force: true } )
```

Warning: Forcing a `rs.reconfig()` (page 860) can lead to *rollback* situations and other difficult to recover from situations. Exercise caution when using this option.

Note: The `rs.reconfig()` (page 860) shell method can force the current primary to step down and causes an election in some situations. When the primary steps down, all clients will disconnect. This is by design. While this typically takes 10-20 seconds, attempt to make these changes during scheduled maintenance periods.

63.8.5 Tag Sets

Tag sets provide custom and configurable *write concern* and *read preferences* for a *replica set*. This section outlines the process for specifying tags for a replica set, for more information see the full documentation of the behavior of *tags sets for write concern* (page 303) and *tag sets for read preference* (page 308).

Important: Custom read preferences and write concerns evaluate tags sets in different ways.

Read preferences consider the value of a tag when selecting a member to read from.

Write concerns do not utilize the value of a tag to select a member except to consider whether or not the value is unique.

Configure tag sets by adding fields and values to the document stored in the `tags` (page 991). Consider the following examples:

Configure Tag Sets

Given the following replica set configuration:

```
{
    "_id" : "rs0",
    "version" : 1,
    "members" : [
            {
                    "_id" : 0,
                    "host" : "mongodb0.example.net:27017"
            },
            {
                    "_id" : 1,
                    "host" : "mongodb1.example.net:27017"
            },
            {
                    "_id" : 2,
                    "host" : "mongodb2.example.net:27017"
            }
     ]
}
```

You could add the tag sets, to the members of this replica set, with the following command sequence in the mongo (page 908) shell:

```
conf = rs.conf()
conf.members[0].tags = { "dc": "east", "use": "production"  }
conf.members[1].tags = { "dc": "east", "use": "reporting"  }
conf.members[2].tags = { "use": "production"  }
rs.reconfig(conf)
```

After this operation the output of rs.conf() (page 859), would resemble the following:

```
{
    "_id" : "rs0",
    "version" : 2,
    "members" : [
            {
                    "_id" : 0,
                    "host" : "mongodb0.example.net:27017",
                    "tags" : {
                            "dc": "east",
                            "use": "production"
                    }
            },
            {
                    "_id" : 1,
                    "host" : "mongodb1.example.net:27017",
                    "tags" : {
                            "dc": "east",
                            "use": "reporting"
                    }
            },
            {
                    "_id" : 2,
                    "host" : "mongodb2.example.net:27017",
                    "tags" : {
                            "use": "production"
                    }
            }
     ]
}
```

Configure Tag Sets for Custom Multi-Data Center Write Concern Mode

Given a five member replica set with members in two data centers:

1. a facility `VA` tagged `dc.va`
2. a facility `GTO` tagged `dc.gto`

Create a custom write concern to require confirmation from two data centers using replica set tags, using the following sequence of operations in the `mongo` (page 908) shell:

1. Create the replica set configuration object `conf`:

   ```
   conf = rs.conf()
   ```

2. Add tags to the replica set members reflecting their locations:

   ```
   conf.members[0].tags = { "dc.va": "rack1"}
   conf.members[1].tags = { "dc.va": "rack2"}
   conf.members[2].tags = { "dc.gto": "rack1"}
   conf.members[3].tags = { "dc.gto": "rack2"}
   conf.members[4].tags = { "dc.va": "rack1"}
   rs.reconfig(conf)
   ```

3. Create a custom `getLastErrorModes` (page 992) setting to ensure that the write operation will propagate to at least one member of each facility:

   ```
   conf.settings = { getLastErrorModes: { MultipleDC : { "dc.va": 1, "dc.gto": 1}}
   ```

4. Reconfigure the replica set using the new `conf` configuration object:

   ```
   rs.reconfig(conf)
   ```

To ensure that a write operation propagators to at least one member of the set in both facilities, then use the `MultipleDC` write concern mode, as follows:

```
db.runCommand( { getLastError: 1, w: "MultipleDC" } )
```

Alternatively, if you want to ensure that each write operation propagates to at least 2 racks in each facility, reconfigure the replica set as follows in the `mongo` (page 908) shell:

1. Create the replica set configuration object `conf`:

   ```
   conf = rs.conf()
   ```

2. Redefine the `getLastErrorModes` (page 992) value to require two different values of both `dc.va` and `dc.gto`:

   ```
   conf.settings = { getLastErrorModes: { MultipleDC : { "dc.va": 2, "dc.gto": 2}}
   ```

3. Reconfigure the replica set using the new `conf` configuration object:

   ```
   rs.reconfig(conf)
   ```

Now, the following write concern operation will only return after the write operation propagates to at least two different racks in the each facility:

```
db.runCommand( { getLastError: 1, w: "MultipleDC" } )
```

Configure Tag Sets for Functional Segregation of Read and Write Operations

Given a replica set with tag sets that reflect:

- data center facility,
- physical rack location of instance, and
- storage system (i.e. disk) type.

Where each member of the set has a tag set that resembles one of the following: [1]

```
{"dc.va": "rack1", disk:"ssd", ssd: "installed" }
{"dc.va": "rack2", disk:"raid"}
{"dc.gto": "rack1", disk:"ssd", ssd: "installed" }
{"dc.gto": "rack2", disk:"raid"}
{"dc.va": "rack1", disk:"ssd", ssd: "installed" }
```

To target a read operation to a member of the replica set with an disk type of `ssd`, you could use the following tag set:

```
{ disk: "ssd" }
```

However, to create comparable write concern modes, you would specify a different set of `getLastErrorModes` (page 992) configuration. Consider the the following sequence of operations in the `mongo` (page 908) shell:

1. Create the replica set configuration object `conf`:

   ```
   conf = rs.conf()
   ```

2. Redefine the `getLastErrorModes` (page 992) value to configure two write concern modes:

   ```
   conf.settings = {
                     "getLastErrorModes" : {
                             "ssd" : {
                                         "ssd" : 1
                             },
                             "MultipleDC" : {
                                     "dc.va" : 1,
                                    "dc.gto" : 1
                             }
                     }
                   }
   ```

3. Reconfigure the replica set using the new `conf` configuration object:

   ```
   rs.reconfig(conf)
   ```

Now, you can specify the `MultipleDC` write concern mode, as in the following operation, to ensure that a write operation propagates to each data center.

```
db.runCommand( { getLastError: 1, w: "MultipleDC" } )
```

Additionally, you can specify the `ssd` write concern mode, as in the following operation, to ensure that a write operation propagates to at least one instance with an SSD.

63.9 Replication Info Reference

The `db.getReplicationInfo()` (page 850) provides current status of the current replica status, using data polled from the "*oplog*". Consider the values of this output when diagnosing issues with replication.

[1] Since read preferences and write concerns use the value of fields in tag sets differently, larger deployments will have some redundancy.

See Also:

"*Replica Set Fundamental Concepts* (page 279)" for more information on replication.

63.9.1 All Nodes

The following fields are present in the output of `db.getReplicationInfo()` (page 850) for both *primary* and *secondary* nodes.

`db.getReplicationInfo.logSizeMB`
: Returns the total size of the *oplog* in megabytes. This refers to the total amount of space allocated to the oplog rather than the current size of operations stored in the oplog.

`db.getReplicationInfo.usedMB`
: Returns the total amount of space used by the *oplog* in megabytes. This refers to the total amount of space currently used by operations stored in the oplog rather than the total amount of space allocated.

63.9.2 Primary Nodes

The following fields appear in the output of `db.getReplicationInfo()` (page 850) for *primary* nodes.

`db.getReplicationInfo.errmsg`
: Returns the last error status.

`db.getReplicationInfo.oplogMainRowCount`
: Returns a counter of the number of items or rows (i.e. *documents*) in the *oplog*.

63.9.3 Secondary Nodes

The following fields appear in the output of `db.getReplicationInfo()` (page 850) for *secondary* nodes.

`db.getReplicationInfo.timeDiff`
: Returns the difference between the first and last operation in the *oplog*, represented in seconds.

`db.getReplicationInfo.timeDiffHours`
: Returns the difference between the first and last operation in the *oplog*, rounded and represented in hours.

`db.getReplicationInfo.tFirst`
: Returns a time stamp for the first (i.e. earliest) operation in the *oplog*. Compare this value to the last write operation issued against the server.

`db.getReplicationInfo.tLast`
: Returns a time stamp for the last (i.e. latest) operation in the *oplog*. Compare this value to the last write operation issued against the server.

`db.getReplicationInfo.now`
: Returns a time stamp reflecting the current time. The shell process generates this value, and the datum may differ slightly from the server time if you're connecting from a remote host as a result. Equivalent to `Date()` (page 800).

63.10 Current Operation Reporting

Changed in version 2.2.

63.10.1 Example Output

The db.currentOp() (page 846) helper in the mongo (page 908) shell reports on the current operations running on the mongod (page 897) instance. The operation returns the inprog array, which contains a document for each in progress operation. Consider the following example output:

```
{
  "inprog": [
             {
                        "opid" : 3434473,
                        "active" : <boolean>,
                        "secs_running" : 0,
                        "op" : "<operation>",
                        "ns" : "<database>.<collection>",
                        "query" : {
                        },
                        "client" : "<host>:<outgoing>",
                        "desc" : "conn57683",
                        "threadId" : "0x7f04a637b700",
                        "connectionId" : 57683,
                        "locks" : {
                                "^" : "w",
                                "^local" : "W",
                                "^<database>" : "W"
                        },
                        "waitingForLock" : false,
                        "msg": "<string>"
                        "numYields" : 0,
                        "progress" : {
                                "done" : <number>,
                                "total" : <number>
                        }
                        "lockStats" : {
                                "timeLockedMicros" : {
                                        "R" : NumberLong(),
                                        "W" : NumberLong(),
                                        "r" : NumberLong(),
                                        "w" : NumberLong()
                                },
                                "timeAcquiringMicros" : {
                                        "R" : NumberLong(),
                                        "W" : NumberLong(),
                                        "r" : NumberLong(),
                                        "w" : NumberLong()
                                }
                        }
             },
            ]
}
```

Optional

You may specify the true argument to db.currentOp() (page 846) to return a more verbose output including idle connections and system operations. For example:

```
db.currentOp(true)
```

Furthermore, active operations (i.e. where active (page 1000) is true) will return additional fields.

63.10.2 Operations

You can use the db.killOp() (page 851) in conjunction with the opid (page 1000) field to terminate a currently running operation.

Note: You cannot use db.killOp() (page 851) to kill a foreground index build.

The following JavaScript operations for the mongo (page 908) shell filter the output of specific types of operations:

- Return all pending write operations:

```
db.currentOp().inprog.forEach(
   function(d){
     if(d.waitingForLock && d.lockType != "read")
        printjson(d)
     })
```

- Return the active write operation:

```
db.currentOp().inprog.forEach(
   function(d){
     if(d.active && d.lockType == "write")
        printjson(d)
     })
```

- Return all active read operations:

```
db.currentOp().inprog.forEach(
   function(d){
     if(d.active && d.lockType == "read")
        printjson(d)
     })
```

63.10.3 Output Reference

Some fields may not appear in all current operation documents, depending on the kind of operation and its state.

currentOp.**opid**
: Holds an identifier for the operation. You can pass this value to db.killOp() (page 851) in the mongo (page 908) shell to terminate the operation.

  Note: You cannot use db.killOp() (page 851) to kill a foreground index build.

currentOp.**active**
: A boolean value, that is true if the operation has started or false if the operation is queued and waiting for a lock to run. active (page 1000) may be true even if the operation has yielded to another operation.

currentOp.**secs_running**
: The duration of the operation in seconds. MongoDB calculates this value by subtracting the current time from the start time of the operation.

  If the operation is not running, (i.e. if active (page 1000) is false,) this field may not appear in the output of db.currentOp() (page 846).

currentOp.**op**
A string that identifies the type of operation. The possible values are:

- insert
- query
- update
- remove
- getmore
- command

currentOp.**ns**
The *namespace* the operation targets. MongoDB forms namespaces using the name of the *database* and the name of the *collection*.

currentOp.**query**
A document containing the current operation's query. The document is empty for operations that do not have queries: getmore, insert, and command.

currentOp.**client**
The IP address (or hostname) and the ephemeral port of the client connection where the operation originates. If your inprog array has operations from many different clients, use this string to relate operations to clients.

For some commands, including findAndModify (page 758) and db.eval() (page 846), the client will be 0.0.0.0:0, rather than an actual client.

currentOp.**desc**
A description of the client. This string includes the connectionId (page 1001).

currentOp.**threadId**
An identifier for the thread that services the operation and its connection.

currentOp.**connectionId**
An identifier for the connection where the operation originated.

currentOp.**locks**
New in version 2.2. The locks (page 1001) document reports on the kinds of locks the operation currently holds. The following kinds of locks are possible:

currentOp.locks.**^**
^ (page 1001) reports on the use of the global lock :for the program:*mongod* instance. All operations must hold the :global lock for some phases of operation.

currentOp.locks.**^local**
^local (page 1001) reports on the lock for the local database. MongoDB uses the local database for a number of operations, but the most frequent use of the local database is for the *oplog* used in replication.

currentOp.locks.**^<database>**
locks.^<database> (page 1001) reports on the lock state for the database that this operation targets.

locks (page 1001) replaces lockType in earlier versions.

currentOp.**lockType**
Changed in version 2.2: The locks (page 1001) replaced the lockType (page 1001) field in 2.2. Identifies the type of lock the operation currently holds. The possible values are:

- read
- write

currentOp.**waitingForLock**
Returns a boolean value. waitingForLock (page 1001) is true if the operation is waiting for a lock and false if the operation has the required lock.

currentOp.**msg**
The msg (page 1002) provides a message that describes the status and progress of the operation. In the case of indexing or mapReduce operations, the field reports the completion percentage.

currentOp.**progress**
Reports on the progress of mapReduce or indexing operations. The progress (page 1002) fields corresponds to the completion percentage in the msg (page 1002) field. The progress (page 1002) specifies the following information:

currentOp.progress.**done**
Reports the number completed.

currentOp.progress.**total**
Reports the total number.

currentOp.**killed**
Returns true if mongod (page 897) instance is in the process of killing the operation.

currentOp.**numYields**
numYields (page 1002) is a counter that reports the number of times the operation has yielded to allow other operations to complete.

Typically, operations yield when they need access to data that MongoDB has not yet fully read into memory. This allows other operations that have data in memory to complete quickly while MongoDB reads in data for the yielding operation.

currentOp.**lockStats**
New in version 2.2. The lockStats (page 1002) document reflects the amount of time the operation has spent both acquiring and holding locks. lockStats (page 1002) reports data on a per-lock type, with the following possible lock types:

- R represents the global read lock,
- W represents the global write lock,
- r represents the database specific read lock, and
- w represents the database specific write lock.

currentOp.**timeLockedMicros**
The timeLockedMicros (page 1002) document reports the amount of time the operation has spent holding a specific lock.

For operations that require more than one lock, like those that lock the local database to update the *oplog*, then the values in this document can be longer than this value may be longer than the total length of the operation (i.e. secs_running (page 1000).)

currentOp.timeLockedMicros.**R**
Reports the amount of time in microseconds the operation has held the global read lock.

currentOp.timeLockedMicros.**W**
Reports the amount of time in microseconds the operation has held the global write lock.

currentOp.timeLockedMicros.**r**
Reports the amount of time in microseconds the operation has held the database specific read lock.

currentOp.timeLockedMicros.**w**
: Reports the amount of time in microseconds the operation has held the database specific write lock.

currentOp.**timeAcquiringMicros**
: The timeAcquiringMicros (page 1003) document reports the amount of time the operation has spent *waiting* to acquire a specific lock.

currentOp.timeAcquiringMicros.**R**
: Reports the mount of time in microseconds the operation has waited for the global read lock.

currentOp.timeAcquiringMicros.**W**
: Reports the mount of time in microseconds the operation has waited for the global write lock.

currentOp.timeAcquiringMicros.**r**
: Reports the mount of time in microseconds the operation has waited for the database specific read lock.

currentOp.timeAcquiringMicros.**w**
: Reports the mount of time in microseconds the operation has waited for the database specific write lock.

63.11 Database Profiler Output

The database profiler captures data information about read and write operations, cursor operations, and database commands. To configure the database profile and set the thresholds for capturing profile data, see the *Analyze Performance of Database Operations* (page 616) section.

The database profiler writes data in the system.profile (page 1020) collection, which is a *capped collection*. To view the profiler's output, use normal MongoDB queries on the system.profile (page 1020) collection.

Note: Because the database profiler writes data to the system.profile (page 1020) collection in a database, the profiler will profile some write activity, even for databases that are otherwise read-only.

63.11.1 Example system.profile Document

The documents in the system.profile (page 1020) collection have the following form. This example document reflects an update operation:

```
{
    "ts" : ISODate("2012-12-10T19:31:28.977Z"),
    "op" : "update",
    "ns" : "social.users",
    "query" : {
        "name" : "jane"
    },
    "updateobj" : {
        "$set" : {
            "likes" : [
                "basketball",
                "trekking"
            ]
        }
    },
```

```
    "nscanned" : 8,
    "moved" : true,
    "nmoved" : 1,
    "nupdated" : 1,
    "keyUpdates" : 0,
    "numYield" : 0,
    "lockStats" : {
        "timeLockedMicros" : {
            "r" : NumberLong(0),
            "w" : NumberLong(258)
        },
        "timeAcquiringMicros" : {
            "r" : NumberLong(0),
            "w" : NumberLong(7)
        }
    },
    "millis" : 0,
    "client" : "127.0.0.1",
    "user" : ""
}
```

63.11.2 Output Reference

For any single operation, the documents created by the database profiler will include a subset of the following fields. The precise selection of fields in these documents depends on the type of operation.

`system.profile.`**`ts`**
: The timestamp of the operation.

`system.profile.`**`op`**
: The type of operation. The possible values are:

  - `insert`
  - `query`
  - `update`
  - `remove`
  - `getmore`
  - `command`

`system.profile.`**`ns`**
: The *namespace* the operation targets. Namespaces in MongoDB take the form of the *database*, followed by a dot (`.`), followed by the name of the *collection*.

`system.profile.`**`query`**
: The query document used. See *Query Specification Documents* (page 139) for more information on these documents, and *Meta Query Operator Quick Reference* (page 885) for more information.

`system.profile.`**`command`**
: The command operation.

`system.profile.`**`updateobj`**
: The *update document* (page 139) passed in during an *update* (page 169) operation.

`system.profile.`**`cursorid`**
: The ID of the cursor accessed by a `getmore` operation.

system.profile.**ntoreturn**
Changed in version 2.2: In 2.0, MongoDB includes this field for `query` and `command` operations. In 2.2, this information MongoDB also includes this field for `getmore` operations. The number of documents the operation specified to return. For example, the `profile` (page 783) command would return one document (a results document) so the `ntoreturn` (page 1004) value would be `1`. The `limit(5)` (page 807) command would return five documents so the `ntoreturn` (page 1004) value would be `5`.

If the `ntoreturn` (page 1004) value is `0`, the command did not specify a number of documents to return, as would be the case with a simple `find()` (page 820) command with no limit specified.

system.profile.**ntoskip**
New in version 2.2. The number of documents the `skip()` (page 812) method specified to skip.

system.profile.**nscanned**
The number of documents that MongoDB scans in the *index* (page 239) in order to carry out the operation.

In general, if `nscanned` (page 1005) is much higher than `nreturned` (page 1005), the database is scanning many objects to find the target objects. Consider creating an index to improve this.

system.profile.**moved**
If `moved` (page 1005) has a value of `true` indicates that the update operation moved one or more documents to a new location on disk. These operations take more time than in-place updates, and typically occur when documents grow as a result of document growth.

system.profile.**nmoved**
New in version 2.2. The number of documents moved on disk by the operation.

system.profile.**nupdated**
New in version 2.2. The number of documents updated by the operation.

system.profile.**keyUpdates**
New in version 2.2. The number of *index* (page 239) keys the update changed in the operation. Changing an index key carries a small performance cost because the database must remove the old key and inserts a new key into the B-tree index.

system.profile.**numYield**
New in version 2.2. The number of times the operation yielded to allow other operations to complete. Typically, operations yield when they need access to data that MongoDB has not yet fully read into memory. This allows other operations that have data in memory to complete while MongoDB reads in data for the yielding operation. For more information, see *the FAQ on when operations yield* (page 654).

system.profile.**lockStats**
New in version 2.2. The time in microseconds the operation spent acquiring and holding locks. This field reports data for the following lock types:

- `R` - global read lock
- `W` - global write lock
- `r` - database-specific read lock
- `w` - database-specific write lock

system.profile.lockStats.**timeLockedMicros**
The time in microseconds the operation held a specific lock. For operations that require more than one lock, like those that lock the `local` database to update the *oplog*, then this value may be longer than the total length of the operation (i.e. `millis` (page 1006).)

system.profile.lockStats.**timeAcquiringMicros**
The time in microseconds the operation spent waiting to acquire a specific lock.

`system.profile.nreturned`
: The number of documents returned by the operation.

`system.profile.responseLength`
: The length in bytes of the operation's result document. A large `responseLength` (page 1006) can affect performance. To limit the size of a the result document for a query operation, you can use any of the following:

  - *Projections* (page 115)
  - The `limit()` method (page 807)
  - The `batchSize()` method (page 804)

`system.profile.millis`
: The time in milliseconds for the server to perform the operation. This time does not include network time nor time to acquire the lock.

`system.profile.client`
: The IP address or hostname of the client connection where the operation originates.

  For some operations, such as `db.eval()` (page 846), the client is `0.0.0.0:0` instead of an actual client.

`system.profile.user`
: The authenticated user who ran the operation.

63.12 Explain Output

This document explains the output of the `$explain` (page 696) operator and the `mongo` (page 908) shell method `explain()` (page 805).

63.12.1 Explain Output

The *Core Explain Output* (page 1008) fields display information for queries on non-sharded collections. For queries on sharded collections, `explain()` (page 805) returns this information for each shard the query accesses.

```
{
  "cursor" : "<Cursor Type and Index>",
  "isMultiKey" : <boolean>,
  "n" : <num>,
  "nscannedObjects" : <num>,
  "nscanned" : <num>,
  "nscannedObjectsAllPlans" : <num>,
  "nscannedAllPlans" : <num>,
  "scanAndOrder" : <boolean>,
  "indexOnly" : <boolean>,
  "nYields" : <num>,
  "nChunkSkips" : <num>,
  "millis" : <num>,
  "indexBounds" : { <index bounds> },
  "allPlans" : [
                { "cursor" : "<Cursor Type and Index>",
                  "n" : <num>,
                  "nscannedObjects" : <num>,
                  "nscanned" : <num>,
                  "indexBounds" : { <index bounds> }
                },
                 ...
```

```
                ],
  "oldPlan" : {
                "cursor" : "<Cursor Type and Index>",
                "indexBounds" : { <index bounds> }
              }
  "server" : "<host:port>",
}
```

63.12.2 `$or` Queries

Queries with `$or` (page 707) operator execute each clause of the `$or` (page 707) expression in parallel and can use separate indexes on the individual clauses. If the query uses indexes on any or all of the query's clause, `explain()` (page 805) contains *output* (page 1008) for each clause as well as the cumulative data for the entire query:

```
{
   "clauses" : [
                   {
                      <core explain output>
                   },
                   {
                      <core explain output>
                   },
                   ...
                ],
   "n" : <num>,
   "nscannedObjects" : <num>,
   "nscanned" : <num>,
   "nscannedObjectsAllPlans" : <num>,
   "nscannedAllPlans" : <num>,
   "millis" : <num>,
   "server" : "<host:port>"
}
```

63.12.3 Sharded Collections

For queries on a sharded collection, the output contains the *Core Explain Output* (page 1008) for each accessed shard and *cumulative shard information* (page 1010):

```
{
   "clusteredType" : "<Shard Access Type>",
   "shards" : {

                "<shard1>" : [
                                {
                                  <core explain output>
                                }
                             ],
                "<shard2>" : [
                                {
                                 <core explain output>
                                }
                             ],
                ...
              },
   "millisShardTotal" : <num>,
```

```
   "millisShardAvg" : <num>,
   "numQueries" : <num>,
   "numShards" : <num>,
   "cursor" : "<Cursor Type and Index>",
   "n" : <num>,
   "nChunkSkips" : <num>,
   "nYields" : <num>,
   "nscanned" : <num>,
   "nscannedAllPlans" : <num>,
   "nscannedObjects" : <num>,
   "nscannedObjectsAllPlans" : <num>,
   "millis" : <num>
}
```

63.12.4 Fields

Core Explain Output

`explain.`**`cursor`**
`cursor` (page 1008) is a string that reports the type of cursor used by the query operation:

- `BasicCursor` indicates a full collection scan.
- `BtreeCursor` indicates that the query used an index. The cursor includes name of the index. When a query uses an index, the output of `explain()` (page 805) includes `indexBounds` (page 1009) details.
- `GeoSearchCursor` indicates that the query used a geospatial index.

`explain.`**`isMultiKey`**
`isMultiKey` (page 1008) is a boolean. When `true`, the query uses a *multikey index* (page 244), where one of the fields in the index holds an array.

`explain.`**`n`**
`n` (page 1008) is a number that reflects the number of documents that match the query selection criteria.

`explain.`**`nscannedObjects`**
Specifies the total number of documents scanned during the query. The `nscannedObjects` (page 1008) may be lower than `nscanned` (page 1008), such as if the index *covers* (page 258) a query. See `indexOnly` (page 1009). Additionally, the `nscannedObjects` (page 1008) may be lower than `nscanned` (page 1008) in the case of multikey index on an array field with duplicate documents.

`explain.`**`nscanned`**
Specifies the total number of documents or index entries scanned during the database operation. You want `n` (page 1008) and `nscanned` (page 1008) to be close in value as possible. The `nscanned` (page 1008) value may be higher than the `nscannedObjects` (page 1008) value, such as if the index *covers* (page 258) a query. See `indexOnly` (page 1009).

`explain.`**`nscannedObjectsAllPlans`**
New in version 2.2. `nscannedObjectsAllPlans` (page 1008) is a number that reflects the total number of documents scanned for all query plans during the database operation.

`explain.`**`nscannedAllPlans`**
New in version 2.2. `nscannedAllPlans` (page 1008) is a number that reflects the total number of documents or index entries scanned for all query plans during the database operation.

`explain.`**`scanAndOrder`**
`scanAndOrder` (page 1008) is a boolean that is `true` when the query **cannot** use the index for returning sorted results.

When `true`, MongoDB must sort the documents after it retrieves them from either an index cursor or a cursor that scans the entire collection.

`explain.`**`indexOnly`**
`indexOnly` (page 1009) is a boolean value that returns `true` when the the query is *covered* (page 258) by the index indicated in the `cursor` (page 1008) field. When an index covers a query, MongoDB can both match the *query conditions* (page 112) **and** return the results using only the index because:

- all the fields in the *query* (page 112) are part of that index, **and**
- all the fields returned in the results set are in the same index.

`explain.`**`nYields`**
`nYields` (page 1009) is a number that reflects the number of times this query yielded the read lock to allow waiting writes execute.

`explain.`**`nChunkSkips`**
`nChunkSkips` (page 1009) is a number that reflects the number of documents skipped because of active chunk migrations in a sharded system. Typically this will be zero. A number greater than zero is ok, but indicates a little bit of inefficiency.

`explain.`**`millis`**
`millis` (page 1009) is a number that reflects the time in milliseconds to complete the query.

`explain.`**`indexBounds`**
`indexBounds` (page 1009) is a document that contains the lower and upper index key bounds. This field resembles one of the following:

```
"indexBounds" : {
                    "start" : { <index key1> : <value>, ...  },
                    "end" : { <index key1> : <value>, ... }
                },

"indexBounds" : { "<field>" : [ [ <lower bound>, <upper bound> ] ],
                  ...
                }
```

`explain.`**`allPlans`**
`allPlans` (page 1009) is an array that holds the list of plans the query optimizer runs in order to select the index for the query. Displays only when the `<verbose>` parameter to `explain()` (page 805) is `true` or `1`.

`explain.`**`oldPlan`**
New in version 2.2. `oldPlan` (page 1009) is a document value that contains the previous plan selected by the query optimizer for the query. Displays only when the `<verbose>` parameter to `explain()` (page 805) is `true` or `1`.

`explain.`**`server`**
New in version 2.2. `server` (page 1009) is a string that reports the MongoDB server.

`$or` Query Output

`explain.`**`clauses`**
`clauses` (page 1009) is an array that holds the *Core Explain Output* (page 1008) information for each clause of the `$or` (page 707) expression. `clauses` (page 1009) is only included when the clauses in the `$or` (page 707) expression use indexes.

Sharded Collections Output

explain.**clusteredType**
clusteredType (page 1010) is a string that reports the access pattern for shards. The value is:

- ParallelSort, if the mongos (page 905) queries shards in parallel.
- SerialServer, if the mongos (page 905) queries shards sequentially.

explain.**shards**
shards (page 1010) is a document value that contains the shards accessed during the query and individual *Core Explain Output* (page 1008) for each shard.

explain.**millisShardTotal**
millisShardTotal (page 1010) is a number that reports the total time in milliseconds for the query to run on the shards.

explain.**millisShardAvg**
millisShardAvg (page 1010) is a number that reports the average time in millisecond for the query to run on each shard.

explain.**numQueries**
numQueries (page 1010) is a number that reports the total number of queries executed.

explain.**numShards**
numShards (page 1010) is a number that reports the total number of shards queried.

63.13 Exit Codes and Statuses

MongoDB will return one of the following codes and statuses when exiting. Use this guide to interpret logs and when troubleshooting issues with mongod (page 897) and mongos (page 905) instances.

0
Returned by MongoDB applications upon successful exit.

2
The specified options are in error or are incompatible with other options.

3
Returned by mongod (page 897) if there is a mismatch between hostnames specified on the command line and in the local.sources (page 1019) collection. mongod (page 897) may also return this status if *oplog* collection in the local database is not readable.

4
The version of the database is different from the version supported by the mongod (page 897) (or mongod.exe (page 912)) instance. The instance exits cleanly. Restart mongod (page 897) with the *--upgrade* (page 902) option to upgrade the database to the version supported by this mongod (page 897) instance.

5
Returned by mongod (page 897) if a moveChunk (page 782) operation fails to confirm a commit.

12
Returned by the mongod.exe (page 912) process on Windows when it receives a Control-C, Close, Break or Shutdown event.

14
Returned by MongoDB applications which encounter an unrecoverable error, an uncaught exception or uncaught signal. The system exits without performing a clean shut down.

20

Message: `ERROR: wsastartup failed <reason>`

Returned by MongoDB applications on Windows following an error in the WSAStartup function.

Message: `NT Service Error`

Returned by MongoDB applications for Windows due to failures installing, starting or removing the NT Service for the application.

45

Returned when a MongoDB application cannot open a file or cannot obtain a lock on a file.

47

MongoDB applications exit cleanly following a large clock skew (32768 milliseconds) event.

48

`mongod` (page 897) exits cleanly if the server socket closes. The server socket is on port `27017` by default, or as specified to the `--port` (page 898) run-time option.

49

Returned by `mongod.exe` (page 912) or `mongos.exe` (page 913) on Windows when either receives a shutdown message from the *Windows Service Control Manager*.

100

Returned by `mongod` (page 897) when the process throws an uncaught exception.

CHAPTER 64

Internal Metadata

64.1 Config Database Contents

The `config` database supports *sharded cluster* operation. See the *Sharding* (page 363) section of this manual for full documentation of sharded clusters.

Warning: Consider the schema of the `config` database *internal* and may change between releases of MongoDB. The `config` database is not a dependable API, and users should not write data to the `config` database in the course of normal operation or maintenance. Modification of the `config` database on a functioning system may lead to instability or inconsistent data sets.

To access a the `config` database, connect to a `mongos` (page 905) instance in a sharded cluster, and use the following helper:

```
use config
```

You can return a list of the collections, with the following helper:

```
show collections
```

64.1.1 Collections

`config.changelog`

Internal MongoDB Metadata

The `config` database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The `changelog` (page 1013) collection stores a document for each change to the metadata of a sharded collection.

Example

The following example displays a single record of a chunk split from a `changelog` (page 1013) collection:

```
{
 "_id" : "<hostname>-<timestamp>-<increment>",
 "server" : "<hostname><:port>",
 "clientAddr" : "127.0.0.1:63381",
 "time" : ISODate("2012-12-11T14:09:21.039Z"),
 "what" : "split",
 "ns" : "<database>.<collection>",
 "details" : {
    "before" : {
       "min" : {
          "<database>" : { $minKey : 1 }
       },
       "max" : {
          "<database>" : { $maxKey : 1 }
       },
       "lastmod" : Timestamp(1000, 0),
       "lastmodEpoch" : ObjectId("000000000000000000000000")
    },
    "left" : {
       "min" : {
          "<database>" : { $minKey : 1 }
       },
       "max" : {
          "<database>" : "<value>"
       },
       "lastmod" : Timestamp(1000, 1),
       "lastmodEpoch" : ObjectId(<...>)
    },
    "right" : {
       "min" : {
          "<database>" : "<value>"
       },
       "max" : {
          "<database>" : { $maxKey : 1 }
       },
       "lastmod" : Timestamp(1000, 2),
       "lastmodEpoch" : ObjectId("<...>")
    }
 }
}
```

Each document in the `changelog` (page 1013) collection contains the following fields:

`config.changelog.`**`_id`**
The value of `changelog._id` is: `<hostname>-<timestamp>-<increment>`.

`config.changelog.`**`server`**
The hostname of the server that holds this data.

`config.changelog.`**`clientAddr`**
A string that holds the address of the client, a `mongos` (page 905) instance that initiates this change.

`config.changelog.`**`time`**
A *ISODate* timestamp that reflects when the change occurred.

`config.changelog.`**`what`**
Reflects the type of change recorded. Possible values are:

- `dropCollection`

- dropCollection.start
- dropDatabase
- dropDatabase.start
- moveChunk.start
- moveChunk.commit
- split
- multi-split

config.changelog.**ns**
: Namespace where the change occurred.

config.changelog.**details**
: A *document* that contains additional details regarding the change. The structure of the details (page 1015) document depends on the type of change.

config.**chunks**

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The chunks (page 1015) collection stores a document for each chunk in the cluster. Consider the following example of a document for a chunk named records.pets-animal_\"cat\":

```
{
   "_id" : "mydb.foo-a_\"cat\"",
   "lastmod" : Timestamp(1000, 3),
   "lastmodEpoch" : ObjectId("5078407bd58b175c5c225fdc"),
   "ns" : "mydb.foo",
   "min" : {
         "animal" : "cat"
   },
   "max" : {
         "animal" : "dog"
   },
   "shard" : "shard0004"
}
```

These documents store the range of values for the shard key that describe the chunk in the min and max fields. Additionally the shard field identifies the shard in the cluster that "owns" the chunk.

config.**collections**

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The collections (page 1015) collection stores a document for each sharded collection in the cluster. Given a collection named pets in the records database, a document in the collections (page 1015) collection would resemble the following:

```
{
    "_id" : "records.pets",
    "lastmod" : ISODate("1970-01-16T15:00:58.107Z"),
    "dropped" : false,
    "key" : {
            "a" : 1
    },
    "unique" : false,
    "lastmodEpoch" : ObjectId("5078407bd58b175c5c225fdc")
}
```

config.databases

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The databases (page 1016) collection stores a document for each database in the cluster, and tracks if the database has sharding enabled. databases (page 1016) represents each database in a distinct document. When a databases have sharding enabled, the primary field holds the name of the *primary shard*.

```
{ "_id" : "admin", "partitioned" : false, "primary" : "config" }
{ "_id" : "mydb", "partitioned" : true, "primary" : "shard0000" }
```

config.lockpings

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The lockpings (page 1016) collection keeps track of the active components in the sharded cluster. Given a cluster with a mongos (page 905) running on example.com:30000, the document in the lockpings (page 1016) collection would resemble:

```
{ "_id" : "example.com:30000:1350047994:16807", "ping" : ISODate("2012-10-12T18:32:54.892Z") }
```

config.locks

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The locks (page 1016) collection stores a distributed lock. This ensures that only one mongos (page 905) instance can perform administrative tasks on the cluster at once. The mongos (page 905) acting as *balancer* takes a lock by inserting a document resembling the following into the locks collection.

```
{
    "_id" : "balancer",
    "process" : "example.net:40000:1350402818:16807",
    "state" : 2,
```

```
    "ts" : ObjectId("507daeedf40e1879df62e5f3"),
    "when" : ISODate("2012-10-16T19:01:01.593Z"),
    "who" : "example.net:40000:1350402818:16807:Balancer:282475249",
    "why" : "doing balance round"
}
```

If a mongos (page 905) holds the balancer lock, the state field has a value of 2, which means that balancer is active. The when field indicates when the balancer began the current operation. Changed in version 2.0: The value of the state field was 1 before MongoDB 2.0.

config.mongos

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The mongos (page 1017) collection stores a document for each mongos (page 905) instance affiliated with the cluster. mongos (page 905) instances send pings to all members of the cluster every 30 seconds so the cluster can verify that the mongos (page 905) is active. The ping field shows the time of the last ping, while the up field reports the uptime of the mongos (page 905) as of the last ping. The cluster maintains this collection for reporting purposes.

The following document shows the status of the mongos (page 905) running on example.com:30000.

```
{ "_id" : "example.com:30000", "ping" : ISODate("2012-10-12T17:08:13.538Z"), "up" : 13699, "wait
```

config.settings

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The settings (page 1017) collection holds the following sharding configuration settings:

- Chunk size. To change chunk size, see *Modify Chunk Size* (page 394).
- Balancer status. To change status, see *Disable the Balancer* (page 399).

The following is an example settings collection:

```
{ "_id" : "chunksize", "value" : 64 }
{ "_id" : "balancer", "stopped" : false }
```

config.shards

Internal MongoDB Metadata

The config database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The shards (page 1017) collection represents each shard in the cluster in a separate document. If the shard is a replica set, the host field displays the name of the replica set, then a slash, then the hostname, as in the following example:

```
{ "_id" : "shard0000", "host" : "shard1/localhost:30000" }
```

If the shard has *tags* (page 408) assigned, this document has a `tags` field, that holds an array of the tags, as in the following example:

```
{ "_id" : "shard0001", "host" : "localhost:30001", "tags": [ "NYC" ] }
```

`config.`**`tags`**

Internal MongoDB Metadata

The `config` database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The `tags` (page 1018) collection holds documents for each tagged shard key range in the cluster. The documents in the `tags` (page 1018) collection resemble the following:

```
{
    "_id" : { "ns" : "records.users", "min" : { "zipcode" : "10001" } },
    "ns" : "records.users",
    "min" : { "zipcode" : "10001" },
    "max" : { "zipcode" : "10281" },
    "tag" : "NYC"
}
```

`config.`**`version`**

Internal MongoDB Metadata

The `config` database is internal: applications and administrators should not modify or depend upon its content in the course of normal operation.

The `version` (page 1018) collection holds the current metadata version number. This collection contains only one document:

To access the `version` (page 1018) collection you must use the `db.getCollection()` (page 848) method. For example, to display the collection's document:

```
mongos> db.getCollection("version").find()
{ "_id" : 1, "version" : 3 }
```

Note: Like all databases in MongoDB, the `config` database contains a `system.indexes` (page 1020) collection contains metadata for all indexes in the database for information on indexes, see *Indexes* (page 239).

64.2 The `local` Database

64.2.1 Overview

Every `mongod` (page 897) instance has its own `local` database, which stores data used in the replication process, and other instance-specific data. The `local` database is invisible to replication: collections in the `local` database are not replicated.

When running with authentication (i.e. `auth` (page 947)), authenticating against the `local` database is equivalent to authenticating against the `admin` database. This authentication gives access to all databases.

In replication, the `local` database store stores internal replication data for each member of a *replica set*. The `local` database contains the following collections used for replication:

64.2.2 Collections on Replica Set Members

`local.system.replset`
: `local.system.replset` (page 1019) holds the replica set's configuration object as its single document. To view the object's configuration information, issue `rs.conf()` (page 859) from the `mongo` (page 908) shell. You can also query this collection directly.

`local.oplog.rs`
: `local.oplog.rs` (page 1019) is the capped collection that holds the *oplog*. You set its size at creation using the `oplogSize` (page 952) setting. To resize the oplog after replica set initiation, use the *Change the Size of the Oplog* (page 336) procedure. For additional information, see the *Oplog Internals* (page 312) topic in this document and the *Oplog* (page 282) topic in the *Replica Set Fundamental Concepts* (page 279) document.

`local.replset.minvalid`
: This contains an object used internally by replica sets to track replication status.

`local.slaves`
: This contains information about each member of the set and the latest point in time that this member has synced to. If this collection becomes out of date, you can refresh it by dropping the collection and allowing MongoDB to automatically refresh it during normal replication:

  ```
  db.getSiblingDB("local").slaves.drop()
  ```

64.2.3 Collections used in Master/Slave Replication

In *master*/*slave* replication, the `local` database contains the following collections:

- On the master:

  `local.oplog.$main`
  : This is the oplog for the master-slave configuration.

  `local.slaves`
  : This contains information about each slave.

- On each slave:

  `local.sources`
  : This contains information about the slave's master server.

64.3 System Collections

64.3.1 Synopsis

MongoDB stores system information in collections that use the `<database>.system.*` *namespace*, which MongoDB reserves for internal use. Do not create collections that begin with `system.`.

MongoDB also stores some additional instance-local metadata in the *local database* (page 1018), specifically for replication purposes.

64.3.2 Collections

System collections include these collections stored directly in the database:

`<database>.system.namespaces`
: The `<database>.system.namespaces` (page 1020) collection contains information about all of the database's collections. Additional namespace metadata exists in the `database.ns` files and is opaque to database users.

`<database>.system.indexes`
: The `<database>.system.indexes` (page 1020) collection lists all the indexes in the database. Add and remove data from this collection via the `ensureIndex()` (page 819) and `dropIndex()` (page 818)

`<database>.system.profile`
: The `<database>.system.profile` (page 1020) collection stores database profiling information. For information on profiling, see *Database Profiling* (page 60).

`<database>.system.users`
: The `<database>.system.users` (page 1020) collection stores credentials for users who have access to the database. For more information on this collection, see *Authentication* (page 90).

`<database>.system.js`
: The `<database>.system.js` (page 1020) collection holds special JavaScript code for use in *server side JavaScript* (page 438). See *Storing Functions Server-side* (page 440) for more information.

CHAPTER 65

General Reference

65.1 MongoDB Limits and Thresholds

65.1.1 Synopsis

This document provides a collection of hard and soft limitations of the MongoDB system.

65.1.2 Limits

BSON Documents

BSON Document Size
The maximum BSON document size is 16 megabytes.

The maximum document size helps ensure that a single document cannot use excessive amount of RAM or, during transmission, excessive amount of bandwidth. To store documents larger than the maximum size, MongoDB provides the GridFS API. See `mongofiles` (page 942) and the documentation for your *driver* (page 435) for more information about GridFS.

Nested Depth for BSON Documents
Changed in version 2.2. MongoDB supports no more than 100 levels of nesting for *BSON documents*.

Namespaces

Namespace Length
Each namespace, including database and collection name, must be shorter than 123 bytes.

Number of Namespaces
The limitation on the number of namespaces is the size of the namespace file divided by 628.

A 16 megabyte namespace file can support approximately 24,000 namespaces. Each index also counts as a namespace.

Size of Namespace File
Namespace files can be no larger than 2047 megabytes.

By default namespace files are 16 megabytes. You can configure the size using the `nssize` (page 949).

Indexes

Index Size
Indexed items can be *no larger* than 1024 bytes.

Number of Indexes per Collection
A single collection can have *no more* than 64 indexes.

Index Name Length
The names of indexes, including their namespace (i.e database and collection name) cannot be longer than 128 characters. The default index name is the concatenation of the field names and index directions.

You can explicitly specify an index name to the `ensureIndex()` (page 819) helper if the default index name is too long.

Unique Indexes in Sharded Collections
MongoDB does not support unique indexes across shards, except when the unique index contains the full shard key as a prefix of the index. In these situations MongoDB will enforce uniqueness across the full key, not a single field.

See Also:

Enforce Unique Keys for Sharded Collections (page 410) for an alternate approach.

Number of Indexed Fields in a Compound Index
There can be no more than 31 fields in a compound index.

Capped Collections

Maximum Number of Documents in a Capped Collection
Capped collections can hold no more than 2^{32} documents.

Replica Sets

Number of Members of a Replica Set
Replica sets can have no more than 12 members.

Number of Voting Members of a Replica Set
Only 7 members of a replica set can have votes at any given time. See can vote *Non-Voting Members* (page 288) for more information

Sharded Clusters

Operations Unavailable in Sharded Environments
The `group` (page 769) does not work with sharding. Use `mapReduce` (page 775) or `aggregate` (page 740) instead.

`db.eval()` (page 846) is incompatible with sharded collections. You may use `db.eval()` (page 846) with un-sharded collections in a shard cluster.

`$where` (page 720) does not permit references to the `db` object from the `$where` (page 720) function. This is uncommon in un-sharded collections.

The `$isolated` (page 699) update modifier does not work in sharded environments.

`$snapshot` (page 717) queries do not work in sharded environments.

Sharding Existing Collection Data Size
MongoDB only allows sharding an existing collection that holds fewer than 256 gigabytes of data.

Note: This limitation *only* applies to sharding collections that have existing data sets, and is *not* a limit on the size of a sharded collection.

See Also:

`Unique Indexes in Sharded Collections` (page 1022)

Operations

Sorted Documents
MongoDB will only return sorted results on fields without an index *if* the sort operation uses less than 32 megabytes of memory.

2d Geospatial queries cannot use the $or operator

See Also:

`$or` (page 707) and *2d Geospatial Indexes* (page 269).

Cannot Kill Foreground Index Build
You cannot use `db.killOp()` (page 851) to kill a foreground index build.

Naming Restrictions

Restrictions on Database Names
The dot (i.e. `.`) character is not permissible in database names.

Database names are case sensitive even if the underlying file system is case insensitive. Changed in version 2.2: For MongoDB instances running on Windows. In 2.2 the following characters are not permissible in database names:

```
/\. "*<>:|?
```

See *Restrictions on Database Names for Windows* (page 1042) for more information.

Restriction on Collection Names
New in version 2.2. Collection names should begin with an underscore or a letter character, and *cannot*:

- contain the `$`.
- be an empty string (e.g. `""`).
- contain the null character.
- begin with the `system.` prefix. (Reserved for internal use.)

See *Are there any restrictions on the names of Collections?* (page 646) and *Restrictions on Collection Names* (page 1041) for more information.

Restrictions on Field Names
Field names cannot contain dots (i.e. `.`), dollar signs (i.e. `$`), or null characters. See *Dollar Sign Operator Escaping* (page 644) for an alternate approach.

65.2 MongoDB Extended JSON

MongoDB *import and export utilities* (page 63) (i.e. `mongoimport` (page 925) and `mongoexport` (page 928)) and MongoDB REST Interfaces render an approximation of MongoDB *BSON* documents in JSON format.

The REST interface supports three different modes for document output:

- *Strict* mode that produces output that conforms to the JSON RFC specifications.
- *JavaScript* mode that produces output that most JavaScript interpreters can process (via the `--jsonp` option)
- `mongo` (page 908) *Shell* mode produces output that the `mongo` (page 908) shell can process. This is "extended" JavaScript format.

MongoDB can process of these representations in REST input.

Special representations of *BSON data* in JSON format make it possible to render information that have no obvious corresponding JSON. In some cases MongoDB supports multiple equivalent representations of the same type information. Consider the following table:

BSON Data Type	Strict Mode	JavaScript Mode (via JSONP)	mongo Shell Mode	Notes
data_binary	{ "$binary": "<bindata>", "$type": "<t>" }	{ "$binary": "<bindata>", "$type": "<t>" }	BinData (<t>, <bindata>)	<bindata> is the base64 representation of a binary string. <t> is the hexadecimal representation of a single byte that indicates the data type.
data_date	{ "$date": <date> }	new Date(<date>)	new Date (<date>)	<date> is the JSON representation of a 64-bit signed integer for milliseconds since epoch UTC (unsigned before version 1.9.1).
data_timestamp	{ "$timestamp": { "t": <t>, "i": <i> } }	{ "$timestamp": { "t": <t>, "i": <i> } }	Timestamp(<t>, <i>)	<t> is the JSON representation of a 32-bit unsigned integer for seconds since epoch. <i> is a 32-bit unsigned integer for the increment.
data_regex	{ "$regex": "<sRegex>", "$options": "<sOptions>" }	/<jRegex>/<jOptions>	/<jRegex>/<jOptions>	<sRegex> is a string of valid JSON characters. <jRegex> is a string that may contain valid JSON characters and unescaped double quote (") characters, but may not contain unescaped forward slash (http://docs.mongodb.o characters. <sOptions> is a string containing the regex options represented by the letters of the alphabet. <jOptions> is a string that may contain only the characters 'g', 'i', 'm' and 's' (added in v1.9). Because the JavaScript and mongo Shell representations support a limited range of options, any nonconforming options will be dropped when converting to this representation.
data_oid	{ "$oid": "<id>" }	{ "$oid": "<id>" }	ObjectId("<id>")	<id> is a 24-character hexadecimal string.

65.3 Glossary

$cmd A virtual *collection* that exposes *MongoDB*'s *database commands*.

_id A field containing a unique ID, typically a BSON *ObjectId*. If not specified, this value is automatically assigned upon the creation of a new document. You can think of the `_id` as the document's *primary key*.

accumulator An *expression* in the *aggregation framework* that maintains state between documents in the *aggregation pipeline*. See: `$group` (page 728) for a list of accumulator operations.

admin database A privileged database named `admin`. Users must have access to this database to run certain administrative commands. See *administrative commands* (page 595) for more information and *Administration Commands* (page 887) for a list of these commands.

aggregation Any of a variety of operations that reduce and summarize large sets of data. SQL's `GROUP` and MongoDB's map-reduce are two examples of aggregation functions.

aggregation framework The MongoDB aggregation framework provides a means to calculate aggregate values without having to use *map-reduce*.

See Also:

Aggregation Framework (page 195).

arbiter A member of a *replica set* that exists solely to vote in *elections*. Arbiters do not replicate data.

See Also:

Delayed Members (page 287)

balancer An internal MongoDB process that runs in the context of a *sharded cluster* and manages the migration of *chunks*. Administrators must disable the balancer for all maintenance operations on a sharded cluster.

box MongoDB's *geospatial* indexes and querying system allow you to build queries around rectangles on two-dimensional coordinate systems. These queries use the `$box` (page 693) operator to define a shape using the lower-left and the upper-right coordinates.

BSON A serialization format used to store documents and make remote procedure calls in MongoDB. "BSON" is a portmanteau of the words "binary" and "JSON". Think of BSON as a binary representation of JSON (JavaScript Object Notation) documents. For a detailed spec, see bsonspec.org.

See Also:

The *Data Type Fidelity* (page 64) section.

BSON types The set of types supported by the *BSON* serialization format. The following types are available:

Type	Number
Double	1
String	2
Object	3
Array	4
Binary data	5
Object id	7
Boolean	8
Date	9
Null	10
Regular Expression	11
JavaScript	13
Symbol	14
JavaScript (with scope)	15
32-bit integer	16
Timestamp	17
64-bit integer	18
Min key	255
Max key	127

btree A data structure used by most database management systems for to store indexes. MongoDB uses b-trees for its indexes.

CAP Theorem Given three properties of computing systems, consistency, availability, and partition tolerance, a distributed computing system can provide any two of these features, but never all three.

capped collection A fixed-sized *collection*. Once they reach their fixed size, capped collections automatically overwrite their oldest entries. MongoDB's *oplog* replication mechanism depends on capped collections. Developers may also use capped collections in their applications.

See Also:

The *Capped Collections* (page 440) page.

checksum A calculated value used to ensure data integrity. The *md5* algorithm is sometimes used as a checksum.

chunk In the context of a *sharded cluster*, a chunk is a contiguous range of *shard key* values assigned to a particular *shard*. Chunk ranges are inclusive of the lower boundary and exclusive of the upper boundary. By default, chunks are 64 megabytes or less. When they grow beyond the configured chunk size, a `mongos` (page 905) splits the chunk into two chunks.

circle MongoDB's *geospatial* indexes and querying system allow you to build queries around circles on two-dimensional coordinate systems. These queries use the `$within` (page 721) operator and the `$center` (page 694) operator to define a circle using the center and the radius of the circle.

client The application layer that uses a database for data persistence and storage. *Drivers* provide the interface level between the application layer and the database server.

cluster A set of `mongod` (page 897) instances running in conjunction to increase database availability and performance. See *sharding* and *replication* for more information on the two different approaches to clustering with MongoDB.

collection Collections are groupings of *BSON documents*. Collections do not enforce a schema, but they are otherwise mostly analogous to *RDBMS* tables.

The documents within a collection may not need the exact same set of fields, but typically all documents in a collection have a similar or related purpose for an application.

All collections exist within a single *database*. The namespace within a database for collections are flat.

See *What is a namespace in MongoDB?* (page 640) and *BSON Documents* (page 135) for more information.

compound index An *index* consisting of two or more keys. See *Indexing Overview* (page 241) for more information.

config database One of three `mongod` (page 897) instances that store all of the metadata associated with a *sharded cluster*.

control script A simple shell script, typically located in the `http://docs.mongodb.org/v2.2/etc/rc.d` or `http://docs.mongodb.org/v2.2/etc/init.d` directory and used by the system's initialization process to start, restart and stop a *daemon* process.

control script A script used by a UNIX-like operating system to start, stop, or restart a *daemon* process. On most systems, you can find these scripts in the `http://docs.mongodb.org/v2.2/etc/init.d/` or `http://docs.mongodb.org/v2.2/etc/rc.d/` directories.

CRUD Create, read, update, and delete. The fundamental operations of any database.

CSV A text-based data format consisting of comma-separated values. This format is commonly used to exchange database between relational databases, since the format is well-suited to tabular data. You can import CSV files using `mongoimport` (page 925).

cursor In MongoDB, a cursor is a pointer to the result set of a *query*, that clients can iterate through to retrieve results. By default, cursors will timeout after 10 minutes of inactivity.

daemon The conventional name for a background, non-interactive process.

data-center awareness A property that allows clients to address members in a system to based upon their location.

Replica sets implement data-center awareness using *tagging*. See `http://docs.mongodb.org/v2.2/data-center-awareness` for more information.

database A physical container for *collections*. Each database gets its own set of files on the file system. A single MongoDB server typically servers multiple databases.

database command Any MongoDB operation other than an insert, update, remove, or query. MongoDB exposes commands as queries against the special *$cmd* collection. For example, the implementation of `count` (page 750) for MongoDB is a command.

See Also:

Database Commands Quick Reference (page 885) for a full list of database commands in MongoDB

database profiler A tool that, when enabled, keeps a record on all long-running operations in a database's `system.profile` collection. The profiler is most often used to diagnose slow queries.

See Also:

Monitoring Database Systems (page 60).

dbpath Refers to the location of MongoDB's data file storage. The default `dbpath` (page 947) is `http://docs.mongodb.org/v2.2/data/db`. Other common data paths include `http://docs.mongodb.org/v2.2/srv/mongodb` and `http://docs.mongodb.org/v2.2/var/lib/mongodb`.

See Also:

`dbpath` (page 947) or *`--dbpath`* (page 899).

delayed member A member of a *replica set* that cannot become primary and applies operations at a specified delay. This delay is useful for protecting data from human error (i.e. unintentionally deleted databases) or updates that have unforeseen effects on the production database.

See Also:

Delayed Members (page 287)

diagnostic log `mongod` (page 897) can create a verbose log of operations with the *`mongod --diaglog`* (page 899) option or through the `diagLogging` (page 753) command. The `mongod` (page 897) creates this log in the directory specified to *`mongod --dbpath`* (page 899). The name of the is `diaglog.<time in hex>`, where "`<time-in-hex>`" reflects the initiation time of logging as a hexadecimal string.

> **Warning:** Setting the diagnostic level to `0` will cause `mongod` (page 897) to stop writing data to the *diagnostic log* file. However, the `mongod` (page 897) instance will continue to keep the file open, even if it is no longer writing data to the file. If you want to rename, move, or delete the diagnostic log you must cleanly shut down the `mongod` (page 897) instance before doing so.

See Also:

`mongod --diaglog` (page 899), `diaglog` (page 948), and `diagLogging` (page 753).

document A record in a MongoDB collection, and the basic unit of data in MongoDB. Documents are analogous to JSON objects, but exist in the database in a more type-rich format known as *BSON*.

dot notation MongoDB uses the *dot notation* to access the elements of an array and to access the fields of a subdocument.

To access an element of an array by the zero-based index position, you concatenate the array name with the dot (`.`) and zero-based index position:

```
'<array>.<index>'
```

To access a field of a subdocument with *dot-notation*, you concatenate the subdocument name with the dot (`.`) and the field name:

```
'<subdocument>.<field>'
```

draining The process of removing or "shedding" *chunks* from one *shard* to another. Administrators must drain shards before removing them from the cluster.

See Also:

`removeShard` (page 785), *sharding*.

driver A client implementing the communication protocol required for talking to a server. The MongoDB drivers provide language-idiomatic methods for interfacing with MongoDB.

See Also:

MongoDB Drivers and Client Libraries (page 435)

election In the context of *replica sets*, an election is the process by which members of a replica set select primaries on startup and in the event of failures.

See Also:

Replica Set Elections (page 280) and *priority*.

eventual consistency A property of a distributed system allowing changes to the system to propagate gradually. In a database system, this means that readable members are not required to reflect the latest writes at all times. In MongoDB, reads to a primary have *strict consistency*; reads to secondaries have *eventual consistency*.

expression In the context of the *aggregation framework*, expressions are the stateless transformations that operate on the data that passes through the *pipeline*.

See Also:

Aggregation Framework (page 195).

failover The process that allows one of the *secondary* members in a *replica set* to become *primary* in the event of a failure.

See Also:

Replica Set Failover (page 280).

field A name-value pair in a *document*. Documents have zero or more fields. Fields are analogous to columns in relational databases.

firewall A system level networking filter that restricts access based on, among other things, IP address. Firewalls form part of effective network security strategy.

fsync A system call that flushes all dirty, in-memory pages to disk. MongoDB calls `fsync()` on its database files at least every 60 seconds.

Geohash A value is a binary representation of the location on a coordinate grid.

geospatial Data that relates to geographical location. In MongoDB, you may index or store geospatial data according to geographical parameters and reference specific coordinates in queries.

GridFS A convention for storing large files in a MongoDB database. All of the official MongoDB drivers support this convention, as does the `mongofiles` program.

See Also:

mongofiles (page 941).

haystack index In the context of *geospatial* queries, haystack indexes enhance searches by creating "bucket" of objects grouped by a second criterion. For example, you might want all geospatial searches to first select along a non-geospatial dimension and then match on location.

hidden member A member of a *replica set* that cannot become primary and is not advertised as part of the set in the *database command* `isMaster` (page 772), which prevents it from receiving read-only queries depending on *read preference*.

See Also:

Hidden Member (page 287), `isMaster` (page 772), `db.isMaster` (page 850), and `local.system.replset.members[n].hidden` (page 990).

idempotent When calling an idempotent operation on a value or state, the operation only affects the value once. Thus, the operation can safely run multiple times without unwanted side effects. In the context of MongoDB, *oplog* entries must be idempotent to support initial synchronization and recovery from certain failure situations. Thus, MongoDB can safely apply oplog entries more than once without any ill effects.

index A data structure that optimizes queries. See *Indexing Overview* (page 241) for more information.

initial sync The *replica set* operation that replicates data from an existing replica set member to a new or restored replica set member.

IPv6 A revision to the IP (Internet Protocol) standard that provides a significantly larger address space to more effectively support the number of hosts on the contemporary Internet.

ISODate The international date format used by `mongo` (page 908). to display dates. E.g. `YYYY-MM-DD HH:MM.SS.milis`.

JavaScript A popular scripting language original designed for web browsers. The MongoDB shell and certain server-side functions use a JavaScript interpreter.

journal A sequential, binary transaction used to bring the database into a consistent state in the event of a hard shutdown. MongoDB enables journaling by default for 64-bit builds of MongoDB version 2.0 and newer. Journal files are pre-allocated and will exist as three 1GB file in the data directory. To make journal files smaller, use `smallfiles` (page 950).

When enabled, MongoDB writes data first to the journal and after to the core data files. MongoDB commits to the journal every 100ms and this is configurable using the `journalCommitInterval` (page 948) runtime option.

To force `mongod` (page 897) to commit to the journal more frequently, you can specify `j:true`. When a write operation with `j:true` pending, `mongod` (page 897) will reduce `journalCommitInterval` (page 948) to a third of the set value.

See Also:

The *Journaling* (page 41) page.

JSON JavaScript Object Notation. A human-readable, plain text format for expressing structured data with support in many programming languages.

JSON document A *JSON* document is a collection of fields and values in a structured format. The following is a sample *JSON document* with two fields:

```
{ name: "MongoDB",
  type: "database" }
```

JSONP *JSON* with Padding. Refers to a method of injecting JSON into applications. Presents potential security concerns.

LVM Logical volume manager. LVM is a program that abstracts disk images from physical devices, and provides a number of raw disk manipulation and snapshot capabilities useful for system management.

map-reduce A data and processing and aggregation paradigm consisting of a "map" phase that selects data, and a "reduce" phase that transforms the data. In MongoDB, you can run arbitrary aggregations over data using map-reduce.

See Also:

The *Map-Reduce* (page 223) page for more information regarding MongoDB's map-reduce implementation, and *Aggregation Framework* (page 195) for another approach to data aggregation in MongoDB.

master In conventional master/*slave* replication, the master database receives all writes. The *slave* instances replicate from the master instance in real time.

md5 `md5` is a hashing algorithm used to efficiently provide reproducible unique strings to identify and *checksum* data. MongoDB uses md5 to identify chunks of data for *GridFS*.

MIME "Multipurpose Internet Mail Extensions." A standard set of type and encoding definitions used to declare the encoding and type of data in multiple data storage, transmission, and email contexts.

mongo The MongoDB Shell. `mongo` connects to `mongod` (page 897) and `mongos` (page 905) instances, allowing administration, management, and testing. `mongo` (page 908) has a JavaScript interface.

See Also:

mongo (page 908) and *mongo Shell JavaScript Quick Reference* (page 889).

mongod The program implementing the MongoDB database server. This server typically runs as a *daemon*.

See Also:

mongod (page 897).

MongoDB The document-based database server described in this manual.

mongos The routing and load balancing process that acts an interface between an application and a MongoDB *sharded cluster*.

See Also:

mongos (page 904).

multi-master replication A *replication* method where multiple database instances can accept write operations to the same data set at any time. Multi-master replication exchanges increased concurrency and availability for a relaxed consistency semantic. MongoDB ensures consistency and, therefore, does not provide multi-master replication.

namespace The canonical name for a collection or index in MongoDB. The namespace is a combination of the database name and the name of the collection or index, like so: `[database-name].[collection-or-index-name]`. All documents belong to a namespace.

natural order The order in which a database stores documents on disk. Typically, the order of documents on disks reflects insertion order, *except* when documents move internal because of document growth due to update operations. However, *Capped collections* guarantee that insertion order and natural order are identical.

When you execute `find()` (page 820) with no parameters, the database returns documents in forward natural order. When you execute `find()` (page 820) and include `sort()` (page 813) with a parameter of `$natural:-1`, the database returns documents in reverse natural order.

ObjectId A special 12-byte *BSON* type that has a high probability an ObjectId represent the time of the ObjectId's creation. MongoDB uses ObjectId values as the default values for *_id* fields.

operator A keyword beginning with a `$` used to express a complex query, update, or data transformation. For example, `$gt` is the query language's "greater than" operator. See the *Query, Update, and Projection Operators Quick Reference* (page 882) for more information about the available operators.

oplog A *capped collection* that stores an ordered history of logical writes to a MongoDB database. The oplog is the basic mechanism enabling *replication* in MongoDB.

See Also:

Oplog Sizes (page 282) and *Change the Size of the Oplog* (page 336).

ordered query plan Query plan that returns results in the order consistent with the `sort()` (page 813) order.

See Also:

Query Optimization (page 118)

padding The extra space allocated to document on the disk to prevent moving a document when it grows as the result of `update()` (page 842) operations.

padding factor An automatically-calibrated constant used to determine how much extra space MongoDB should allocate per document container on disk. A padding factor of 1 means that MongoDB will allocate only the amount of space needed for the document. A padding factor of 2 means that MongoDB will allocate twice the amount of space required by the document.

page fault The event that occurs when a process requests stored data (i.e. a page) from memory that the operating system has moved to disk.

See Also:

Storage FAQ: What are page faults? (page 674)

partition A distributed system architecture that splits data into ranges. *Sharding* is a kind of partitioning.

pcap A packet capture format used by `mongosniff` (page 938) to record packets captured from network interfaces and display them as human-readable MongoDB operations.

PID A process identifier. On UNIX-like systems, a unique integer PID is assigned to each running process. You can use a PID to inspect a running process and send signals to it.

pipe A communication channel in UNIX-like systems allowing independent processes to send and receive data. In the UNIX shell, piped operations allow users to direct the output of one command into the input of another.

pipeline The series of operations in the *aggregation* process.

See Also:

Aggregation Framework (page 195).

polygon MongoDB's *geospatial* indexes and querying system allow you to build queries around multi-sided polygons on two-dimensional coordinate systems. These queries use the `$within` (page 721) operator and a sequence of points that define the corners of the polygon.

powerOf2Sizes A per-*collection* setting that changes and normalizes the way that MongoDB allocates space for each *document* in an effort to maximize storage reuse reduce fragmentation. This is the default for *TTL Collections* (page 458). See `collMod` (page 744) and `usePowerOf2Sizes` (page 744) for more information. New in version 2.2.

pre-splitting An operation, performed before inserting data that divides the range of possible shard key values into chunks to facilitate easy insertion and high write throughput. When deploying a *sharded cluster*, in some cases pre-splitting will expedite the initial distribution of documents among shards by manually dividing the collection into chunks rather than waiting for the MongoDB *balancer* to create chunks during the course of normal operation.

primary In a *replica set*, the primary member is the current *master* instance, which receives all write operations.

primary key A record's unique, immutable identifier. In an *RDBMS*, the primary key is typically an integer stored in each row's `id` field. In MongoDB, the *_id* field holds a document's primary key which is usually a BSON *ObjectId*.

primary shard For a database where *sharding* is enabled, the primary shard holds all un-sharded collections.

priority In the context of *replica sets*, priority is a configurable value that helps determine which members in a replica set are most likely to become *primary*.

See Also:

Replica Set Member Priority (page 280)

projection A document given to a *query* that specifies which fields MongoDB will return from the documents in the result set.

query A read request. MongoDB queries use a *JSON*-like query language that includes a variety of *query operators* with names that begin with a `$` character. In the `mongo` (page 908) shell, you can issue queries using the `db.collection.find()` (page 820) and `db.collection.findOne()` (page 825) methods.

query optimizer For each query, the MongoDB query optimizer generates a query plan that matches the query to the index that produces the fastest results. The optimizer then uses the query plan each time the `mongod` (page 897) receives the query. If a collection changes significantly, the optimizer creates a new query plan.

See Also:

Query Optimization (page 118)

RDBMS Relational Database Management System. A database management system based on the relational model, typically using *SQL* as the query language.

read preference A setting on the MongoDB *drivers* (page 435) that determines how the clients direct read operations. Read preference affects all replica sets including shards. By default, drivers direct all reads to *primaries* for *strict consistency*. However, you may also direct reads to secondaries for *eventually consistent* reads.

See Also:

Read Preference (page 306)

read-lock In the context of a reader-writer lock, a lock that while held allows concurrent readers, but no writers.

record size The space allocated for a document including the padding.

recovering A *replica set* member status indicating that a member is not ready to begin normal activities of a secondary or primary. Recovering members are unavailable for reads.

replica pairs The precursor to the MongoDB *replica sets*. Deprecated since version 1.6.

replica set A cluster of MongoDB servers that implements master-slave replication and automated failover. MongoDB's recommended replication strategy.

See Also:

Replication (page 277) and *Replica Set Fundamental Concepts* (page 279).

replication A feature allowing multiple database servers to share the same data, thereby ensuring redundancy and facilitating load balancing. MongoDB supports two flavors of replication: master-slave replication and replica sets.

See Also:

replica set, *sharding*, *Replication* (page 277). and *Replica Set Fundamental Concepts* (page 279).

replication lag The length of time between the last operation in the primary's *oplog* last operation applied to a particular *secondary* or *slave*. In general, you want to keep replication lag as small as possible.

See Also:

Replication Lag (page 295)

resident memory The subset of an application's memory currently stored in physical RAM. Resident memory is a subset of *virtual memory*, which includes memory mapped to physical RAM and to disk.

REST An API design pattern centered around the idea of resources and the *CRUD* operations that apply to them. Typically implemented over HTTP. MongoDB provides a simple HTTP REST interface that allows HTTP clients to run commands against the server.

rollback A process that, in certain replica set situations, reverts writes operations to ensure the consistency of all replica set members.

secondary In a *replica set*, the `secondary` members are the current *slave* instances that replicate the contents of the master database. Secondary members may handle read requests, but only the *primary* members can handle write operations.

secondary index A database *index* that improves query performance by minimizing the amount of work that the query engine must perform to fulfill a query.

set name In the context of a *replica set*, the `set name` refers to an arbitrary name given to a replica set when it's first configured. All members of a replica set must have the same name specified with the `replSet` (page 952) setting (or `--replSet` (page 903) option for `mongod` (page 897).)

See Also:

replication, *Replication* (page 277) and *Replica Set Fundamental Concepts* (page 279).

shard A single replica set that stores some portion of a sharded cluster's total data set. See *sharding*.

See Also:

The documents in the *Sharding* (page 363) section of manual.

shard key In a sharded collection, a shard key is the field that MongoDB uses to distribute documents among members of the *sharded cluster*.

sharded cluster The set of nodes comprising a *sharded* MongoDB deployment. A sharded cluster consists of three config processes, one or more replica sets, and one or more `mongos` (page 905) routing processes.

See Also:

The documents in the *Sharding* (page 363) section of manual.

sharding A database architecture that enable horizontal scaling by splitting data into key ranges among two or more replica sets. This architecture is also known as "range-based partitioning." See *shard*.

See Also:

The documents in the *Sharding* (page 363) section of manual.

shell helper A number of *database commands* (page 885) have "helper" methods in the `mongo` shell that provide a more concise syntax and improve the general interactive experience.

See Also:

mongo (page 908) and *mongo Shell JavaScript Quick Reference* (page 889).

single-master replication A *replication* topology where only a single database instance accepts writes. Single-master replication ensures consistency and is the replication topology employed by MongoDB.

slave In conventional *master*/slave replication, slaves are read-only instances that replicate operations from the *master* database. Data read from slave instances may not be completely consistent with the master. Therefore, applications requiring consistent reads must read from the master database instance.

split The division between *chunks* in a *sharded cluster*.

SQL Structured Query Language (SQL) is a common special-purpose programming language used for interaction with a relational database including access control as well as inserting, updating, querying, and deleting data. There are some similar elements in the basic SQL syntax supported by different database vendors, but most implementations have their own dialects, data types, and interpretations of proposed SQL standards. Complex SQL is generally not directly portable between major *RDBMS* products. `SQL` is often used as metonym for relational databases.

SSD Solid State Disk. A high-performance disk drive that uses solid state electronics for persistence, as opposed to the rotating platters and movable read/write heads used by traditional mechanical hard drives.

standalone In MongoDB, a standalone is an instance of `mongod` (page 897) that is running as a single server and not as part of a *replica set*.

strict consistency A property of a distributed system requiring that all members always reflect the latest changes to the system. In a database system, this means that any system that can provide data must reflect the latest writes at all times. In MongoDB, reads to a primary have *strict consistency*; reads to secondary members have *eventual consistency*.

sync The *replica set* operation where members replicate data from the *primary*. Replica sets synchronize data at two different points:

- *Initial sync* occurs when MongoDB creates new databases on a new or restored *replica set* member, populating the the member with the replica set's data.
- "Replication" occurs continually after initial sync and keeps the member updated with changes to the replica set's data.

syslog On UNIX-like systems, a logging process that provides a uniform standard for servers and processes to submit logging information.

tag One or more labels applied to a given replica set member that clients may use to issue data-center aware operations.

TSV A text-based data format consisting of tab-separated values. This format is commonly used to exchange database between relational databases, since the format is well-suited to tabular data. You can import TSV files using `mongoimport` (page 925).

TTL Stands for "time to live," and represents an expiration time or period for a given piece of information to remain in a cache or other temporary storage system before the system deletes it or ages it out.

unique index An index that enforces uniqueness for a particular field across a single collection.

unordered query plan Query plan that returns results in an order inconsistent with the `sort()` (page 813) order.

See Also:

Query Optimization (page 118)

upsert A kind of update that either updates the first document matched in the provided query selector or, if no document matches, inserts a new document having the fields implied by the query selector and the update operation.

virtual memory An application's working memory, typically residing on both disk an in physical RAM.

working set The collection of data that MongoDB uses regularly. This data is typically (or preferably) held in RAM.

write concern Specifies whether a write operation has succeeded. Write concern allows your application to detect insertion errors or unavailable `mongod` (page 897) instances. For *replica sets*, you can configure write concern to confirm replication to a specified number of members.

See Also:

Write Concern (page 124), *Write Operations* (page 123), and *Write Concern for Replica Sets* (page 303).

write-lock A lock on the database for a given writer. When a process writes to the database, it takes an exclusive write-lock to prevent other processes from writing or reading.

writeBacks The process within the sharding system that ensures that writes issued to a *shard* that isn't responsible for the relevant chunk, get applied to the proper shard.

See Also:

The *genindex* may provide useful insight into the reference material in this manual.

CHAPTER 66

Release Notes

Always install the latest, stable version of MongoDB. See *release-version-numbers* for more information.

See the following release notes for an account of the changes in major versions. Release notes also include instructions for upgrade.

66.1 Current Stable Release

(*2.2-series*)

66.1.1 Release Notes for MongoDB 2.2

See the `full index of this page` for a complete list of changes included in 2.2.

- Upgrading (page 1037)
- Changes (page 1039)
- Licensing Changes (page 1045)
- Resources (page 1046)

Upgrading

MongoDB 2.2 is a production release series and succeeds the 2.0 production release series.

MongoDB 2.0 data files are compatible with 2.2-series binaries without any special migration process. However, always perform the upgrade process for replica sets and sharded clusters using the procedures that follow.

Always upgrade to the latest point release in the 2.2 point release. Currently the latest release of MongoDB is 2.2.4.

Synopsis

- `mongod` (page 897), 2.2 is a drop-in replacement for 2.0 and 1.8.

- Check your *driver* (page 435) documentation for information regarding required compatibility upgrades, and always run the recent release of your driver.

  Typically, only users running with authentication, will need to upgrade drivers before continuing with the upgrade to 2.2.

- For all deployments using authentication, upgrade the drivers (i.e. client libraries), before upgrading the `mongod` (page 897) instance or instances.

- For all upgrades of sharded clusters:

  – turn off the balancer during the upgrade process. See the *Disable the Balancer* (page 399) section for more information.

  – upgrade all `mongos` (page 905) instances before upgrading any `mongod` (page 897) instances.

Other than the above restrictions, 2.2 processes can interoperate with 2.0 and 1.8 tools and processes. You can safely upgrade the `mongod` (page 897) and `mongos` (page 905) components of a deployment one by one while the deployment is otherwise operational. Be sure to read the detailed upgrade procedures below before upgrading production systems.

Upgrading a Standalone `mongod`

1. Download binaries of the latest release in the 2.2 series from the MongoDB Download Page.
2. Shutdown your `mongod` (page 897) instance. Replace the existing binary with the 2.2 `mongod` (page 897) binary and restart MongoDB.

Upgrading a Replica Set

You can upgrade to 2.2 by performing a "rolling" upgrade of the set by upgrading the members individually while the other members are available to minimize downtime. Use the following procedure:

1. Upgrade the *secondary* members of the set one at a time by shutting down the `mongod` (page 897) and replacing the 2.0 binary with the 2.2 binary. After upgrading a `mongod` (page 897) instance, wait for the member to recover to `SECONDARY` state before upgrading the next instance. To check the member's state, issue `rs.status()` (page 861) in the `mongo` (page 908) shell.
2. Use the `mongo` (page 908) shell method `rs.stepDown()` (page 862) to step down the *primary* to allow the normal *failover* (page 280) procedure. `rs.stepDown()` (page 862) expedites the failover procedure and is preferable to shutting down the primary directly.

   Once the primary has stepped down and another member has assumed `PRIMARY` state, as observed in the output of `rs.status()` (page 861), shut down the previous primary and replace `mongod` (page 897) binary with the 2.2 binary and start the new process.

   Note: Replica set failover is not instant but will render the set unavailable to read or accept writes until the failover process completes. Typically this takes 10 seconds or more. You may wish to plan the upgrade during a predefined maintenance window.

Upgrading a Sharded Cluster

Use the following procedure to upgrade a sharded cluster:

- *Disable the balancer* (page 399).

- Upgrade all `mongos` (page 905) instances *first*, in any order.
- Upgrade all of the `mongod` (page 897) config server instances using the *stand alone* (page 1038) procedure. To keep the cluster online, be sure that at all times at least one config server is up.
- Upgrade each shard's replica set, using the *upgrade procedure for replica sets* (page 1038) detailed above.
- re-enable the balancer.

Note: Balancing is not currently supported in *mixed* 2.0.x and 2.2.0 deployments. Thus you will want to reach a consistent version for all shards within a reasonable period of time, e.g. same-day. See SERVER-6902 for more information.

Changes

Major Features

Aggregation Framework The aggregation framework makes it possible to do aggregation operations without needing to use *map-reduce*. The `aggregate` (page 740) command exposes the aggregation framework, and the `db.collection.aggregate()` (page 815) helper in the `mongo` (page 908) shell provides an interface to these operations. Consider the following resources for background on the aggregation framework and its use:

- Documentation: *Aggregation Framework* (page 195)
- Reference: *Aggregation Framework Reference* (page 211)
- Examples: *Aggregation Framework Examples* (page 201)

TTL Collections TTL collections remove expired data from a collection, using a special index and a background thread that deletes expired documents every minute. These collections are useful as an alternative to *capped collections* in some cases, such as for data warehousing and caching cases, including: machine generated event data, logs, and session information that needs to persist in a database for only a limited period of time.

For more information, see the *Expire Data from Collections by Setting TTL* (page 458) tutorial.

Concurrency Improvements MongoDB 2.2 increases the server's capacity for concurrent operations with the following improvements:

1. DB Level Locking
2. Improved Yielding on Page Faults
3. Improved Page Fault Detection on Windows

To reflect these changes, MongoDB now provides changed and improved reporting for concurrency and use, see *locks* (page 966) and *recordStats* (page 978) in *server status* (page 965) and see *current operation output* (page 998), `db.currentOp()` (page 846), *mongotop* (page 935), and *mongostat* (page 931).

Improved Data Center Awareness with Tag Aware Sharding MongoDB 2.2 adds additional support for geographic distribution or other custom partitioning for sharded collections in *clusters*. By using this "tag aware" sharding, you can automatically ensure that data in a sharded database system is always on specific shards. For example, with tag aware sharding, you can ensure that data is closest to the application servers that use that data most frequently.

Shard tagging controls data location, and is complementary but separate from replica set tagging, which controls *read preference* (page 306) and *write concern* (page 124). For example, shard tagging can pin all "USA" data to one or

more logical shards, while replica set tagging can control which mongod (page 897) instances (e.g. "production" or "reporting") the application uses to service requests.

See the documentation for the following helpers in the mongo (page 908) shell that support tagged sharding configuration:

- sh.addShardTag() (page 864)
- sh.addTagRange() (page 865)
- sh.removeShardTag() (page 869)

Also, see *Tag Aware Sharding* (page 408).

Fully Supported Read Preference Semantics All MongoDB clients and drivers now support full *read preferences* (page 306), including consistent support for a full range of *read preference modes* (page 306) and *tag sets* (page 308). This support extends to the mongos (page 905) and applies identically to single replica sets and to the replica sets for each shard in a *sharded cluster*.

Additional read preference support now exists in the mongo (page 908) shell using the readPref() (page 811) cursor method.

Compatibility Changes

Authentication Changes MongoDB 2.2 provides more reliable and robust support for authentication clients, including drivers and mongos (page 905) instances.

If your cluster runs with authentication:

- For all drivers, use the latest release of your driver and check its release notes.
- In sharded environments, to ensure that your cluster remains available during the upgrade process you **must** use the *upgrade procedure for sharded clusters* (page 1038).

findAndModify Returns Null Value for Upserts that Perform Inserts In version 2.2, for *upsert* that perform inserts with the new option set to false, findAndModify (page 758) commands will now return the following output:

```
{ 'ok': 1.0, 'value': null }
```

In the mongo (page 908) shell, upsert findAndModify (page 758) operations that perform inserts (with new set to false.)only output a null value.

In version 2.0 these operations would return an empty document, e.g. { }.

See: SERVER-6226 for more information.

mongodump Output can only Restore to 2.2 MongoDB Instances If you use the mongodump (page 915) tool from the 2.2 distribution to create a dump of a database, you must use a 2.2 version of mongorestore (page 918) to restore that dump.

See: SERVER-6961 for more information.

`ObjectId().toString()` Returns String Literal `ObjectId("...")` In version 2.2, the `ObjectId.toString()` (page 802) method returns the string representation of the *ObjectId()* (page 142) object and has the format `ObjectId("...")`.

Consider the following example that calls the `toString()` (page 802) method on the `ObjectId("507c7f79bcf86cd7994f6c0e")` object:

```
ObjectId("507c7f79bcf86cd7994f6c0e").toString()
```

The method now returns the *string* `ObjectId("507c7f79bcf86cd7994f6c0e")`.

Previously, in version 2.0, the method would return the *hexadecimal string* `507c7f79bcf86cd7994f6c0e`.

If compatibility between versions 2.0 and 2.2 is required, use *ObjectId().str* (page 142), which holds the hexadecimal string value in both versions.

`ObjectId().valueOf()` Returns hexadecimal string In version 2.2, the `ObjectId.valueOf()` (page 802) method returns the value of the *ObjectId()* (page 142) object as a lowercase hexadecimal string.

Consider the following example that calls the `valueOf()` (page 802) method on the `ObjectId("507c7f79bcf86cd7994f6c0e")` object:

```
ObjectId("507c7f79bcf86cd7994f6c0e").valueOf()
```

The method now returns the *hexadecimal string* `507c7f79bcf86cd7994f6c0e`.

Previously, in version 2.0, the method would return the *object* `ObjectId("507c7f79bcf86cd7994f6c0e")`.

If compatibility between versions 2.0 and 2.2 is required, use *ObjectId().str* (page 142) attribute, which holds the hexadecimal string value in both versions.

Behavioral Changes

Restrictions on Collection Names In version 2.2, collection names cannot:

- contain the `$`.
- be an empty string (e.g. `""`).

This change does not affect collections created with now illegal names in earlier versions of MongoDB.

These new restrictions are in addition to the existing restrictions on collection names which are:

- A collection name should begin with a letter or an underscore.
- A collection name cannot contain the null character.
- Begin with the `system.` prefix. MongoDB reserves `system.` for system collections, such as the `system.indexes` collection.
- The maximum size of a collection name is 128 characters, including the name of the database. However, for maximum flexibility, collections should have names less than 80 characters.

Collections names may have any other valid UTF-8 string.

See the SERVER-4442 and the *Are there any restrictions on the names of Collections?* (page 646) FAQ item.

Restrictions on Database Names for Windows Database names running on Windows can no longer contain the following characters:

```
/\. "*<>:|?
```

The names of the data files include the database name. If you attempt to upgrade a database instance with one or more of these characters, `mongod` (page 897) will refuse to start.

Change the name of these databases before upgrading. See SERVER-4584 and SERVER-6729 for more information.

`_id` Fields and Indexes on Capped Collections All *capped collections* now have an `_id` field by default, *if* they exist outside of the `local` database, and now have indexes on the `_id` field. This change only affects capped collections created with 2.2 instances and does not affect existing capped collections.

See: SERVER-5516 for more information.

New `$elemMatch` Projection Operator The `$elemMatch` (page 722) operator allows applications to narrow the data returned from queries so that the query operation will only return the first matching element in an array. See the *$elemMatch (projection)* (page 722) documentation and the SERVER-2238 and SERVER-828 issues for more information.

Windows Specific Changes

Windows XP is Not Supported As of 2.2, MongoDB does not support Windows XP. Please upgrade to a more recent version of Windows to use the latest releases of MongoDB. See SERVER-5648 for more information.

Service Support for `mongos.exe` You may now run `mongos.exe` (page 913) instances as a Windows Service. See the *mongos.exe* (page 913) reference and *MongoDB as a Windows Service* (page 19) and SERVER-1589 for more information.

Log Rotate Command Support MongoDB for Windows now supports log rotation by way of the `logRotate` (page 775) database command. See SERVER-2612 for more information.

New Build Using SlimReadWrite Locks for Windows Concurrency Labeled "2008+" on the Downloads Page, this build for 64-bit versions of Windows Server 2008 R2 and for Windows 7 or newer, offers increased performance over the standard 64-bit Windows build of MongoDB. See SERVER-3844 for more information.

Tool Improvements

Index Definitions Handled by `mongodump` and `mongorestore` When you specify the *`--collection`* (page 916) option to `mongodump` (page 915), `mongodump` (page 915) will now backup the definitions for all indexes that exist on the source database. When you attempt to restore this backup with `mongorestore` (page 918), the target `mongod` (page 897) will rebuild all indexes. See SERVER-808 for more information.

`mongorestore` (page 918) now includes the *`--noIndexRestore`* (page 920) option to provide the preceding behavior. Use *`--noIndexRestore`* (page 920) to prevent `mongorestore` (page 918) from building previous indexes.

`mongooplog` for Replaying Oplogs The `mongooplog` (page 922) tool makes it possible to pull *oplog* entries from `mongod` (page 897) instance and apply them to another `mongod` (page 897) instance. You can use `mongooplog` (page 922) to achieve point-in-time backup of a MongoDB data set. See the SERVER-3873 case and the *mongooplog* (page 922) documentation.

Authentication Support for `mongotop` and `mongostat` `mongotop` (page 935) and `mongostat` (page 931) now contain support for username/password authentication. See SERVER-3875 and SERVER-3871 for more information regarding this change. Also consider the documentation of the following options for additional information:

- *`mongotop --username`* (page 936)
- *`mongotop --password`* (page 936)
- *`mongostat --username`* (page 932)
- *`mongostat --password`* (page 932)

Write Concern Support for `mongoimport` and `mongorestore` `mongoimport` (page 925) now provides an option to halt the import if the operation encounters an error, such as a network interruption, a duplicate key exception, or a write error. The *`--stopOnError`* (page 927) option will produce an error rather than silently continue importing data. See SERVER-3937 for more information.

In `mongorestore` (page 918), the *`--w`* (page 920) option provides support for configurable write concern.

`mongodump` Support for Reading from Secondaries You can now run `mongodump` (page 915) when connected to a *secondary* member of a *replica set*. See SERVER-3854 for more information.

`mongoimport` Support for full 16MB Documents Previously, `mongoimport` (page 925) would only import documents that were less than 4 megabytes in size. This issue is now corrected, and you may use `mongoimport` (page 925) to import documents that are at least 16 megabytes ins size. See SERVER-4593 for more information.

`Timestamp()` Extended JSON format MongoDB extended JSON now includes a new `Timestamp()` type to represent the Timestamp type that MongoDB uses for timestamps in the *oplog* among other contexts.

This permits tools like `mongooplog` (page 922) and `mongodump` (page 915) to query for specific timestamps. Consider the following `mongodump` (page 915) operation:

```
mongodump --db local --collection oplog.rs --query '{"ts":{"$gt":{"$timestamp" : {"t": 1344969612000,
```

See SERVER-3483 for more information.

Shell Improvements

Improved Shell User Interface 2.2 includes a number of changes that improve the overall quality and consistency of the user interface for the `mongo` (page 908) shell:

- Full Unicode support.
- Bash-like line editing features. See SERVER-4312 for more information.
- Multi-line command support in shell history. See SERVER-3470 for more information.
- Windows support for the `edit` command. See SERVER-3998 for more information.

Helper to load Server-Side Functions The `db.loadServerScripts()` (page 851) loads the contents of the current database's `system.js` collection into the current `mongo` (page 908) shell session. See SERVER-1651 for more information.

Support for Bulk Inserts If you pass an array of *documents* to the `insert()` (page 830) method, the `mongo` (page 908) shell will now perform a bulk insert operation. See SERVER-3819 and SERVER-2395 for more information.

Note: For bulk inserts on sharded clusters, the `getLastError` (page 766) command alone is insufficient to verify success. Applications should must verify the success of bulk inserts in application logic.

Operations

Support for Logging to Syslog See the SERVER-2957 case and the documentation of the `syslog` (page 946) runtime option or the *`mongod --syslog`* (page 898) and *`mongos --syslog`* (page 906) command line-options.

`touch` Command Added the `touch` (page 798) command to read the data and/or indexes from a collection into memory. See: SERVER-2023 and `touch` (page 798) for more information.

`indexCounters` No Longer Report Sampled Data `indexCounters` now report actual counters that reflect index use and state. In previous versions, these data were sampled. See SERVER-5784 and `indexCounters` for more information.

Padding Specifiable on `compact` Command See the documentation of the `compact` (page 746) and the SERVER-4018 issue for more information.

Added Build Flag to Use System Libraries The Boost library, version 1.49, is now embedded in the MongoDB code base.

If you want to build MongoDB binaries using system Boost libraries, you can pass `scons` using the `--use-system-boost` flag, as follows:

```
scons --use-system-boost
```

When building MongoDB, you can also pass `scons` a flag to compile MongoDB using only system libraries rather than the included versions of the libraries. For example:

```
scons --use-system-all
```

See the SERVER-3829 and SERVER-5172 issues for more information.

Memory Allocator Changed to TCMalloc To improve performance, MongoDB 2.2 uses the TCMalloc memory allocator from Google Perftools. For more information about this change see the SERVER-188 and SERVER-4683. For more information about TCMalloc, see the documentation of TCMalloc itself.

Replication

Improved Logging for Replica Set Lag When *secondary* members of a replica set fall behind in replication, `mongod` (page 897) now provides better reporting in the log. This makes it possible to track replication in general and identify what process may produce errors or halt replication. See SERVER-3575 for more information.

Replica Set Members can Sync from Specific Members The new `replSetSyncFrom` (page 791) command and new `rs.syncFrom()` (page 862) helper in the `mongo` (page 908) shell make it possible for you to manually configure from which member of the set a replica will poll *oplog* entries. Use these commands to override the default selection logic if needed. Always exercise caution with `replSetSyncFrom` (page 791) when overriding the default behavior.

Replica Set Members will not Sync from Members Without Indexes Unless `buildIndexes: false` To prevent inconsistency between members of replica sets, if the member of a replica set has `buildIndexes` (page 990) set to `true`, other members of the replica set will *not* sync from this member, unless they also have `buildIndexes` (page 990) set to `true`. See SERVER-4160 for more information.

New Option To Configure Index Pre-Fetching during Replication By default, when replicating options, *secondaries* will pre-fetch *Indexes* (page 239) associated with a query to improve replication throughput in most cases. The `replIndexPrefetch` (page 952) setting and `--replIndexPrefetch` (page 903) option allow administrators to disable this feature or allow the `mongod` (page 897) to pre-fetch only the index on the `_id` field. See SERVER-6718 for more information.

Map Reduce Improvements

In 2.2 Map Reduce received the following improvements:

- Improved support for sharded MapReduce, and
- MapReduce will retry jobs following a config error.

Sharding Improvements

Index on Shard Keys Can Now Be a Compound Index If your shard key uses the prefix of an existing index, then you do not need to maintain a separate index for your shard key in addition to your existing index. This index, however, cannot be a multi-key index. See the "*Shard Key Indexes* (page 377)" documentation and SERVER-1506 for more information.

Migration Thresholds Modified The *migration thresholds* (page 378) have changed in 2.2 to permit more even distribution of *chunks* in collections that have smaller quantities of data. See the *Migration Thresholds* (page 378) documentation for more information.

Licensing Changes

Added License notice for Google Perftools (TCMalloc Utility). See the License Notice and the SERVER-4683 for more information.

Resources

- MongoDB Downloads.
- All JIRA issues resolved in 2.2.
- All backwards incompatible changes.
- All third party license notices.
- What's New in MongoDB 2.2 Online Conference.

See `http://docs.mongodb.org/v2.2/release-notes/2.2-changes` for an overview of all changes in 2.2.

66.2 Previous Stable Releases

66.2.1 Release Notes for MongoDB 2.0

See the `full index of this page` for a complete list of changes included in 2.0.

- Upgrading (page 1046)
- Changes (page 1047)
- Resources (page 1051)

Upgrading

Although the major version number has changed, MongoDB 2.0 is a standard, incremental production release and works as a drop-in replacement for MongoDB 1.8.

Preparation

Read through all release notes before upgrading, and ensure that no changes will affect your deployment.

If you create new indexes in 2.0, then downgrading to 1.8 is possible but you must reindex the new collections.

`mongoimport` (page 925) and `mongoexport` (page 928) now correctly adhere to the CSV spec for handling CSV input/output. This may break existing import/export workflows that relied on the previous behavior. For more information see SERVER-1097.

Journaling is **enabled by default** in 2.0 for 64-bit builds. If you still prefer to run without journaling, start `mongod` (page 897) with the `--nojournal` (page 900) run-time option. Otherwise, MongoDB creates journal files during startup. The first time you start `mongod` (page 897) with journaling, you will see a delay as `mongod` (page 897) creates new files. In addition, you may see reduced write throughput.

2.0 `mongod` (page 897) instances are interoperable with 1.8 `mongod` (page 897) instances; however, for best results, upgrade your deployments using the following procedures:

Upgrading a Standalone `mongod`

1. Download the v2.0.x binaries from the MongoDB Download Page.

2. Shutdown your mongod (page 897) instance. Replace the existing binary with the 2.0.x mongod (page 897) binary and restart MongoDB.

Upgrading a Replica Set

1. Upgrade the *secondary* members of the set one at a time by shutting down the mongod (page 897) and replacing the 1.8 binary with the 2.0.x binary from the MongoDB Download Page.
2. To avoid losing the last few updates on failover you can temporarily halt your application (failover should take less than 10 seconds), or you can set *write concern* (page 124) in your application code to confirm that each update reaches multiple servers.
3. Use the rs.stepDown() (page 862) to step down the primary to allow the normal *failover* (page 280) procedure.

   rs.stepDown() (page 862) and replSetStepDown (page 790) provide for shorter and more consistent failover procedures than simply shutting down the primary directly.

   When the primary has stepped down, shut down its instance and upgrade by replacing the mongod (page 897) binary with the 2.0.x binary.

Upgrading a Sharded Cluster

1. Upgrade all *config server* instances *first*, in any order. Since config servers use two-phase commit, *shard* configuration metadata updates will halt until all are up and running.
2. Upgrade mongos (page 905) routers in any order.

Changes

Compact Command

A compact (page 746) command is now available for compacting a single collection and its indexes. Previously, the only way to compact was to repair the entire database.

Concurrency Improvements

When going to disk, the server will yield the write lock when writing data that is not likely to be in memory. The initial implementation of this feature now exists:

See SERVER-2563 for more information.

The specific operations yield in 2.0 are:

- Updates by _id
- Removes
- Long cursor iterations

Default Stack Size

MongoDB 2.0 reduces the default stack size. This change can reduce total memory usage when there are many (e.g., 1000+) client connections, as there is a thread per connection. While portions of a thread's stack can be swapped out if unused, some operating systems do this slowly enough that it might be an issue. The default stack size is lesser of the system setting or 1MB.

Index Performance Enhancements

v2.0 includes significant improvements to the *index* (page 621). Indexes are often 25% smaller and 25% faster (depends on the use case). When upgrading from previous versions, the benefits of the new index type are realized only if you create a new index or re-index an old one.

Dates are now signed, and the max index key size has increased slightly from 819 to 1024 bytes.

All operations that create a new index will result in a 2.0 index by default. For example:

- Reindexing results on an older-version index results in a 2.0 index. However, reindexing on a secondary does *not* work in versions prior to 2.0. Do not reindex on a secondary. For a workaround, see SERVER-3866.
- The `repairDatabase` command converts indexes to a 2.0 indexes.

To convert all indexes for a given collection to the *2.0 type* (page 1048), invoke the `compact` (page 746) command.

Once you create new indexes, downgrading to 1.8.x will require a re-index of any indexes created using 2.0. See *Build Old Style Indexes* (page 621).

Sharding Authentication

Applications can now use authentication with *sharded clusters*.

Replica Sets

Hidden Nodes in Sharded Clusters In 2.0, `mongos` (page 905) instances can now determine when a member of a replica set becomes "hidden" without requiring a restart. In 1.8, `mongos` (page 905) if you reconfigured a member as hidden, you *had* to restart `mongos` (page 905) to prevent queries from reaching the hidden member.

Priorities Each *replica set* member can now have a priority value consisting of a floating-point from 0 to 1000, inclusive. Priorities let you control which member of the set you prefer to have as *primary* the member with the highest priority that can see a majority of the set will be elected primary.

For example, suppose you have a replica set with three members, `A`, `B`, and `C`, and suppose that their priorities are set as follows:

- `A`'s priority is `2`.
- `B`'s priority is `3`.
- `C`'s priority is `1`.

During normal operation, the set will always chose `B` as primary. If `B` becomes unavailable, the set will elect `A` as primary.

For more information, see the *Member Priority* (page 280) documentation.

Data-Center Awareness You can now "tag" *replica set* members to indicate their location. You can use these tags to design custom *write rules* (page 124) across data centers, racks, specific servers, or any other architecture choice.

For example, an administrator can define rules such as "very important write" or `customerData` or "audit-trail" to replicate to certain servers, racks, data centers, etc. Then in the application code, the developer would say:

```
db.foo.insert(doc, {w : "very important write"})
```

which would succeed if it fulfilled the conditions the DBA defined for "very important write".

For more information, see Tagging.

Drivers may also support tag-aware reads. Instead of specifying `slaveOk`, you specify `slaveOk` with tags indicating which data-centers to read from. For details, see the *MongoDB Drivers and Client Libraries* (page 435) documentation.

`w : majority` You can also set `w` to `majority` to ensure that the write propagates to a majority of nodes, effectively committing it. The value for "majority" will automatically adjust as you add or remove nodes from the set.

For more information, see *Write Concern* (page 303).

Reconfiguration with a Minority Up If the majority of servers in a set has been permanently lost, you can now force a reconfiguration of the set to bring it back online.

For more information see *Reconfigure a Replica Set with Unavailable Members* (page 346).

Primary Checks for a Caught up Secondary before Stepping Down To minimize time without a *primary*, the `rs.stepDown()` (page 862) method will now fail if the primary does not see a *secondary* within 10 seconds of its latest optime. You can force the primary to step down anyway, but by default it will return an error message.

See also *Force a Member to Become Primary* (page 338).

Extended Shutdown on the Primary to Minimize Interruption When you call the `shutdown` (page 795) command, the *primary* will refuse to shut down unless there is a *secondary* whose optime is within 10 seconds of the primary. If such a secondary isn't available, the primary will step down and wait up to a minute for the secondary to be fully caught up before shutting down.

Note that to get this behavior, you must issue the `shutdown` (page 795) command explicitly; sending a signal to the process will not trigger this behavior.

You can also force the primary to shut down, even without an up-to-date secondary available.

Maintenance Mode When `repair` or `compact` (page 746) runs on a *secondary*, the secondary will automatically drop into "recovering" mode until the operation finishes. This prevents clients from trying to read from it while it's busy.

Geospatial Features

Multi-Location Documents Indexing is now supported on documents which have multiple location objects, embedded either inline or in nested sub-documents. Additional command options are also supported, allowing results to return with not only distance but the location used to generate the distance.

For more information, see Multi-location Documents.

Polygon searches Polygonal `$within` (page 721) queries are also now supported for simple polygon shapes. For details, see the `$within` (page 721) operator documentation.

Journaling Enhancements

- Journaling is now enabled by default for 64-bit platforms. Use the `--nojournal` command line option to disable it.
- The journal is now compressed for faster commits to disk.
- A new *`--journalCommitInterval`* (page 900) run-time option exists for specifying your own group commit interval. 100ms is the default (same as in 1.8).
- A new `{ getLastError: { j: true } }` (page 766) option is available to wait for the group commit. The group commit will happen sooner when a client is waiting on `{j: true}`. If journaling is disabled, `{j: true}` is a no-op.

New `ContinueOnError` Option for Bulk Insert

Set the `continueOnError` option for bulk inserts, in the *driver* (page 435), so that bulk insert will continue to insert any remaining documents even if an insert fails, as is the case with duplicate key exceptions or network interruptions. The `getLastError` (page 766) command will report whether any inserts have failed, not just the last one. If multiple errors occur, the client will only receive the most recent `getLastError` (page 766) results.

See OP_INSERT.

Note: For bulk inserts on sharded clusters, the `getLastError` (page 766) command alone is insufficient to verify success. Applications should must verify the success of bulk inserts in application logic.

Map Reduce

Output to a Sharded Collection Using the new `sharded` flag, it is possible to send the result of a map/reduce to a sharded collection. Combined with the `reduce` or `merge` flags, it is possible to keep adding data to very large collections from map/reduce jobs.

For more information, see MapReduce Output Options and *mapReduce* (page 775).

Performance Improvements Map/reduce performance will benefit from the following:

- Larger in-memory buffer sizes, reducing the amount of disk I/O needed during a job
- Larger javascript heap size, allowing for larger objects and less GC
- Supports pure JavaScript execution with the `jsMode` flag. See *mapReduce* (page 775).

New Querying Features

Additional regex options: `s` Allows the dot (`.`) to match all characters including new lines. This is in addition to the currently supported `i`, `m` and `x`. See Regular Expressions and `$regex` (page 713).

$and A special boolean `$and` (page 692) query operator is now available.

Command Output Changes

The output of the `validate` (page 799) command and the documents in the `system.profile` collection have both been enhanced to return information as BSON objects with keys for each value rather than as free-form strings.

Shell Features

Custom Prompt You can define a custom prompt for the `mongo` (page 908) shell. You can change the prompt at any time by setting the prompt variable to a string or a custom JavaScript function returning a string. For examples, see Custom Prompt.

Default Shell Init Script On startup, the shell will check for a `.mongorc.js` file in the user's home directory. The shell will execute this file after connecting to the database and before displaying the prompt.

If you would like the shell not to run the `.mongorc.js` file automatically, start the shell with *`--norc`* (page 908).

For more information, see *mongo* (page 908).

Most Commands Require Authentication

In 2.0, when running with authentication (e.g. `auth` (page 947)) *all* database commands require authentication, *except* the following commands.

- `isMaster` (page 772)
- `authenticate` (page 741)
- `getnonce` (page 768)
- `buildInfo` (page 742)
- `ping` (page 783)
- `isdbgrid` (page 773)

Resources

- MongoDB Downloads
- All JIRA Issues resolved in 2.0
- All Backward Incompatible Changes

66.2.2 Release Notes for MongoDB 1.8

See the `full index of this page` for a complete list of changes included in 1.8.

- Upgrading (page 1052)
- Changes (page 1055)
- Resources (page 1057)

Upgrading

MongoDB 1.8 is a standard, incremental production release and works as a drop-in replacement for MongoDB 1.6, except:

- *Replica set* members should be upgraded in a particular order, as described in *Upgrading a Replica Set* (page 1052).
- The `mapReduce` (page 775) command has changed in 1.8, causing incompatibility with previous releases. `mapReduce` (page 775) no longer generates temporary collections (thus, `keepTemp` has been removed). Now, you must always supply a value for `out`. See the `out` field options in the `mapReduce` (page 775) document. If you use MapReduce, this also likely means you need a recent version of your client driver.

Preparation

Read through all release notes before upgrading and ensure that no changes will affect your deployment.

Upgrading a Standalone `mongod`

1. Download the v1.8.x binaries from the MongoDB Download Page.
2. Shutdown your `mongod` (page 897) instance.
3. Replace the existing binary with the 1.8.x `mongod` (page 897) binary.
4. Restart MongoDB.

Upgrading a Replica Set

1.8.x *secondaries* **can** replicate from 1.6.x *primaries*.

1.6.x secondaries **cannot** replicate from 1.8.x primaries.

Thus, to upgrade a *replica set* you must replace all of your secondaries first, then the primary.

For example, suppose you have a replica set with a primary, an *arbiter* and several secondaries. To upgrade the set, do the following:

1. For the arbiter:
   (a) Shut down the arbiter.
   (b) Restart it with the 1.8.x binary from the MongoDB Download Page.
2. Change your config (optional) to prevent election of a new primary.

   It is possible that, when you start shutting down members of the set, a new primary will be elected. To prevent this, you can give all of the secondaries a priority of `0` before upgrading, and then change them back afterwards. To do so:

   (a) Record your current config. Run `rs.config()` (page 859) and paste the results into a text file.
   (b) Update your config so that all secondaries have priority `0`. For example:

```
config = rs.conf()
{
     "_id" : "foo",
     "version" : 3,
     "members" : [
```

```
                {
                        "_id" : 0,
                        "host" : "ubuntu:27017"
                },
                {
                        "_id" : 1,
                        "host" : "ubuntu:27018"
                },
                {
                        "_id" : 2,
                        "host" : "ubuntu:27019",
                        "arbiterOnly" : true
                }
                {
                        "_id" : 3,
                        "host" : "ubuntu:27020"
                },
                {
                        "_id" : 4,
                        "host" : "ubuntu:27021"
                },
        ]
}
config.version++
3
rs.isMaster()
{
        "setName" : "foo",
        "ismaster" : false,
        "secondary" : true,
        "hosts" : [
                "ubuntu:27017",
                "ubuntu:27018"
        ],
        "arbiters" : [
                "ubuntu:27019"
        ],
        "primary" : "ubuntu:27018",
        "ok" : 1
}
// for each secondary
config.members[0].priority = 0
config.members[3].priority = 0
config.members[4].priority = 0
rs.reconfig(config)
```

3. For each secondary:

   (a) Shut down the secondary.

   (b) Restart it with the 1.8.x binary from the MongoDB Download Page.

4. If you changed the config, change it back to its original state:

```
config = rs.conf()
config.version++
config.members[0].priority = 1
config.members[3].priority = 1
config.members[4].priority = 1
rs.reconfig(config)
```

5. Shut down the primary (the final 1.6 server), and then restart it with the 1.8.x binary from the MongoDB Download Page.

Upgrading a Sharded Cluster

1. Turn off the balancer:

```
mongo <a_mongos_hostname>
use config
db.settings.update({_id:"balancer"},{$set : {stopped:true}}, true)
```

2. For each *shard*:
   - If the shard is a *replica set*, follow the directions above for *Upgrading a Replica Set* (page 1052).
   - If the shard is a single `mongod` (page 897) process, shut it down and then restart it with the 1.8.x binary from the MongoDB Download Page.
3. For each `mongos` (page 905):
   (a) Shut down the `mongos` (page 905) process.
   (b) Restart it with the 1.8.x binary from the MongoDB Download Page.
4. For each config server:
   (a) Shut down the config server process.
   (b) Restart it with the 1.8.x binary from the MongoDB Download Page.
5. Turn on the balancer:

```
use config
db.settings.update({_id:"balancer"},{$set : {stopped:false}})
```

Returning to 1.6

If for any reason you must move back to 1.6, follow the steps above in reverse. Please be careful that you have not inserted any documents larger than 4MB while running on 1.8 (where the max size has increased to 16MB). If you have you will get errors when the server tries to read those documents.

Journaling Returning to 1.6 after using 1.8 *Journaling* (page 41) works fine, as journaling does not change anything about the data file format. Suppose you are running 1.8.x with journaling enabled and you decide to switch back to 1.6. There are two scenarios:

- If you shut down cleanly with 1.8.x, just restart with the 1.6 mongod binary.
- If 1.8.x shut down uncleanly, start 1.8.x up again and let the journal files run to fix any damage (incomplete writes) that may have existed at the crash. Then shut down 1.8.x cleanly and restart with the 1.6 mongod binary.

Changes

Journaling

MongoDB now supports write-ahead *Journaling* (page 41) to facilitate fast crash recovery and durability in the storage engine. With journaling enabled, a `mongod` (page 897) can be quickly restarted following a crash without needing to repair the *collections*. The aggregation framework makes it possible to do aggregation

Sparse and Covered Indexes

Sparse Indexes (page 246) are indexes that only include documents that contain the fields specified in the index. Documents missing the field will not appear in the index at all. This can significantly reduce index size for indexes of fields that contain only a subset of documents within a *collection*.

Covered Indexes (page 258) enable MongoDB to answer queries entirely from the index when the query only selects fields that the index contains.

Incremental MapReduce Support

The `mapReduce` (page 775) command supports new options that enable incrementally updating existing *collections*. Previously, a MapReduce job could output either to a temporary collection or to a named permanent collection, which it would overwrite with new data.

You now have several options for the output of your MapReduce jobs:

- You can merge MapReduce output into an existing collection. Output from the Reduce phase will replace existing keys in the output collection if it already exists. Other keys will remain in the collection.
- You can now re-reduce your output with the contents of an existing collection. Each key output by the reduce phase will be reduced with the existing document in the output collection.
- You can replace the existing output collection with the new results of the MapReduce job (equivalent to setting a permanent output collection in previous releases)
- You can compute MapReduce inline and return results to the caller without persisting the results of the job. This is similar to the temporary collections generated in previous releases, except results are limited to 8MB.

For more information, see the `out` field options in the `mapReduce` (page 775) document.

Additional Changes and Enhancements

1.8.1

- Sharding migrate fix when moving larger chunks.
- Durability fix with background indexing.
- Fixed mongos concurrency issue with many incoming connections.

1.8.0

- All changes from 1.7.x series.

1.7.6

- Bug fixes.

1.7.5

- *Journaling* (page 41).
- Extent allocation improvements.
- Improved *replica set* connectivity for `mongos` (page 905).
- `getLastError` (page 766) improvements for *sharding*.

1.7.4

- `mongos` (page 905) routes `slaveOk` queries to *secondaries* in *replica sets*.
- New `mapReduce` (page 775) output options.
- *Sparse Indexes* (page 246).

1.7.3

- Initial *covered index* (page 258) support.
- Distinct can use data from indexes when possible.
- `mapReduce` (page 775) can merge or reduce results into an existing collection.
- `mongod` (page 897) tracks and `mongostat` (page 931) displays network usage. See *mongostat* (page 931).
- Sharding stability improvements.

1.7.2

- `$rename` (page 714) operator allows renaming of fields in a document.
- `db.eval()` (page 846) not to block.
- Geo queries with sharding.
- *`mongostat --discover`* (page 932) option
- Chunk splitting enhancements.
- Replica sets network enhancements for servers behind a nat.

1.7.1

- Many sharding performance enhancements.
- Better support for `$elemMatch` (page 722) on primitives in embedded arrays.
- Query optimizer enhancements on range queries.
- Window service enhancements.
- Replica set setup improvements.
- `$pull` (page 711) works on primitives in arrays.

1.7.0

- Sharding performance improvements for heavy insert loads.
- Slave delay support for replica sets.
- `getLastErrorDefaults` (page 992) for replica sets.
- Auto completion in the shell.
- Spherical distance for geo search.
- All fixes from 1.6.1 and 1.6.2.

Release Announcement Forum Pages

- 1.8.1, 1.8.0
- 1.7.6, 1.7.5, 1.7.4, 1.7.3, 1.7.2, 1.7.1, 1.7.0

Resources

- MongoDB Downloads
- All JIRA Issues resolved in 1.8

66.2.3 Release Notes for MongoDB 1.6

See the `full index of this page` for a complete list of changes included in 1.6.

- Upgrading (page 1057)
- Sharding (page 1057)
- Replica Sets (page 1058)
- Other Improvements (page 1058)
- Installation (page 1058)
- 1.6.x Release Notes (page 1058)
- 1.5.x Release Notes (page 1058)

Upgrading

MongoDB 1.6 is a drop-in replacement for 1.4. To upgrade, simply shutdown `mongod` (page 897) then restart with the new binaries.

Please note that you should upgrade to the latest version of whichever driver you're using. Certain drivers, including the Ruby driver, will require the upgrade, and all the drivers will provide extra features for connecting to replica sets.

Sharding

Sharding (page 363) is now production-ready, making MongoDB horizontally scalable, with no single point of failure. A single instance of `mongod` (page 897) can now be upgraded to a distributed cluster with zero downtime when the need arises.

- *Sharding* (page 363)

- *Deploy a Sharded Cluster* (page 383)
- *Convert a Replica Set to a Replicated Sharded Cluster* (page 601)

Replica Sets

Replica sets (page 277), which provide automated failover among a cluster of `n` nodes, are also now available.

Please note that replica pairs are now deprecated; we strongly recommend that replica pair users upgrade to replica sets.

- *Replication* (page 277)
- *Deploy a Replica Set* (page 323)
- *Convert a Standalone to a Replica Set* (page 327)

Other Improvements

- The `w` option (and `wtimeout`) forces writes to be propagated to `n` servers before returning success (this works especially well with replica sets)
- *$or queries* (page 707)
- Improved concurrency
- *$slice* (page 726) operator for returning subsets of arrays
- 64 indexes per collection (formerly 40 indexes per collection)
- 64-bit integers can now be represented in the shell using NumberLong
- The `findAndModify` (page 758) command now supports upserts. It also allows you to specify fields to return
- $showDiskLoc option to see disk location of a document
- Support for IPv6 and UNIX domain sockets

Installation

- Windows service improvements
- The C++ client is a separate tarball from the binaries

1.6.x Release Notes

- 1.6.5

1.5.x Release Notes

- 1.5.8
- 1.5.7
- 1.5.6
- 1.5.5
- 1.5.4

- 1.5.3
- 1.5.2
- 1.5.1
- 1.5.0

You can see a full list of all changes on JIRA.

Thank you everyone for your support and suggestions!

66.2.4 Release Notes for MongoDB 1.4

See the `full index of this page` for a complete list of changes included in 1.4.

- Upgrading (page 1059)
- Core Server Enhancements (page 1059)
- Replication and Sharding (page 1059)
- Deployment and Production (page 1060)
- Query Language Improvements (page 1060)
- Geo (page 1060)

Upgrading

We're pleased to announce the 1.4 release of MongoDB. 1.4 is a drop-in replacement for 1.2. To upgrade you just need to shutdown `mongod` (page 897), then restart with the new binaries. (Users upgrading from release 1.0 should review the *1.2 release notes* (page 1060), in particular the instructions for upgrading the DB format.)

Release 1.4 includes the following improvements over release 1.2:

Core Server Enhancements

- *concurrency* (page 653) improvements
- indexing memory improvements
- *background index creation* (page 247)
- better detection of regular expressions so the index can be used in more cases

Replication and Sharding

- better handling for restarting slaves offline for a while
- fast new slaves from snapshots (`--fastsync`)
- configurable slave delay (`--slavedelay`)
- replication handles clock skew on master
- *$inc* (page 699) replication fixes
- sharding alpha 3 - notably 2-phase commit on config servers

Deployment and Production

- *configure "slow threshold" for profiling* (page 616)
- ability to do *fsync + lock* (page 763) for backing up raw files
- option for separate directory per db (`--directoryperdb`)
- `http://localhost:28017/_status` to get serverStatus via http
- REST interface is off by default for security (`--rest` to enable)
- can rotate logs with a db command, *logRotate* (page 775)
- enhancements to *serverStatus* (page 965) command (db.serverStatus()) - counters and *replication lag* (page 295) stats
- new *mongostat* (page 931) tool

Query Language Improvements

- *$all* (page 691) with regex
- *$not* (page 707)
- partial matching of array elements *$elemMatch* (page 722)
- $ operator for updating arrays
- *$addToSet* (page 691)
- *$unset* (page 720)
- *$pull* (page 711) supports object matching
- *$set* (page 716) with array indices

Geo

- *2d geospatial search* (page 269)
- geo *$center* (page 694) and *$box* (page 693) searches

66.2.5 Release Notes for MongoDB 1.2.x

See the `full index of this page` for a complete list of changes included in 1.2.

- New Features (page 1061)
- DB Upgrade Required (page 1061)
- Replication Changes (page 1061)
- mongoimport (page 1061)
- field filter changing (page 1061)

New Features

- More indexes per collection
- Faster index creation
- Map/Reduce
- Stored JavaScript functions
- Configurable fsync time
- Several small features and fixes

DB Upgrade Required

There are some changes that will require doing an upgrade if your previous version is <= 1.0.x. If you're already using a version >= 1.1.x then these changes aren't required. There are 2 ways to do it:

- `--upgrade`
  - stop your `mongod` (page 897) process
  - run `./mongod --upgrade`
  - start `mongod` (page 897) again
- use a slave
  - start a slave on a different port and data directory
  - when its synced, shut down the master, and start the new slave on the regular port.

Ask in the forums or IRC for more help.

Replication Changes

- There have been minor changes in replication. If you are upgrading a master/slave setup from <= 1.1.2 you have to update the slave first.

mongoimport

- `mongoimport json` has been removed and is replaced with *mongoimport* (page 925) that can do json/csv/tsv

field filter changing

- We've changed the semantics of the field filter a little bit. Previously only objects with those fields would be returned. Now the field filter only changes the output, not which objects are returned. If you need that behavior, you can use *$exists* (page 695)

66.3 Other MongoDB Release Notes

66.3.1 Default Write Concern Change

These release notes outline a change to all driver interfaces released in November 2012. See release notes for specific drivers for additional information.

Changes

As of the releases listed below, there are two major changes to all drivers:

1. All drivers will add a new top-level connection class that will increase consistency for all MongoDB client interfaces.

   This change is non-backward breaking: existing connection classes will remain in all drivers for a time, and will continue to operate as expected. However, those previous connection classes are now deprecated as of these releases, and will eventually be removed from the driver interfaces.

   The new top-level connection class is named `MongoClient`, or similar depending on how host languages handle namespacing.

2. The default write concern on the new `MongoClient` class will be to acknowledge all write operations [1]. This will allow your application to receive acknowledgment of all write operations.

   See the documentation of *Write Concern* (page 124) for more information about write concern in MongoDB.

   Please migrate to the new `MongoClient` class expeditiously.

Releases

The following driver releases will include the changes outlined in *Changes* (page 1062). See each driver's release notes for a full account of each release as well as other related driver-specific changes.

- C#, version 1.7
- Java, version 2.10.0
- Node.js, version 1.2
- Perl, version 0.501.1
- PHP, version 1.4
- Python, version 2.4
- Ruby, version 1.8

[1] The drivers will call `getLastError` (page 766) without arguments, which is logically equivalent to the `w: 1` option; however, this operation allows *replica set* users to override the default write concern with the `getLastErrorDefaults` (page 992) setting in the *Replica Set Configuration* (page 989).

Part XV

About MongoDB Documentation

The MongoDB Manual contains comprehensive documentation on the MongoDB *document*-oriented database management system. This page describes the manual's licensing, editions, and versions, and describes how to make a change request and how to contribute to the manual.

For more information on MongoDB, see MongoDB: A Document Oriented Database. To download MongoDB, see the downloads page.

CHAPTER 67

License

Editions

In addition to the MongoDB Manual, you can also access this content in the following editions:

- ePub Format
- Single HTML Page
- PDF Format

You also can access PDF files that contain subsets of the MongoDB Manual:

- MongoDB Reference Manual
- MongoDB Use Case Guide
- MongoDB CRUD Operation Introduction

For Emacs users Info/Texinfo users, the following experimental Texinfo manuals are available for offline use:

- MongoDB Manual Texinfo (tar.gz)
- MongoDB Reference Manual (tar.gz)
- MongoDB CRUD Operation Introduction (tar.gz)

Important: The `texinfo` manuals are experimental. If you find an issue with one of these editions, please file an issue in the DOCS Jira project.

CHAPTER 69

Version and Revisions

This version of the manual reflects version 2.2 of MongoDB.

See the MongoDB Documentation Project Page for an overview of all editions and output formats of the MongoDB Manual. You can see the full revision history and track ongoing improvements and additions for all versions of the manual from its GitHub repository.

This edition reflects "`v2.2`" branch of the documentation as of the "`7ae169c88b77556eab50a651d6e5122f7ed8510e`" revision. This branch is explicitly accessible via "http://docs.mongodb.org/v2.2" and you can always reference the commit of the current manual in the release.txt file.

The most up-to-date, current, and stable version of the manual is always available at "http://docs.mongodb.org/manual/".

CHAPTER 70

Report an Issue or Make a Change Request

To report an issue with this manual or to make a change request, file a ticket at the MongoDB DOCS Project on Jira.

Contribute to the Documentation

71.1 MongoDB Manual Translation

The original authorship language for all MongoDB documentation is American English. However, ensuring that speakers of other languages can read and understand the documentation is of critical importance to the documentation project.

In this direction, the MongoDB Documentation project uses the service provided by Smartling to translate the MongoDB documentation into additional non-English languages. This translation project is largely supported by the work of volunteer translators from the MongoDB community who contribute to the translation effort.

If you would like to volunteer to help translate the MongoDB documentation, please:

- complete the 10gen/MongoDB Contributor Agreement, and
- create an account on Smartling at translate.docs.mongodb.org.

Please use the same email address you use to sign the contributor as you use to create your Smartling account.

The mongodb-translators user group exists to facilitate collaboration between translators and the documentation team at large. You can join the Google Group without signing the contributor's agreement.

We currently have the following languages configured:

- Arabic
- Chinese
- Czech
- French
- German
- Hungarian
- Indonesian
- Italian
- Japanese
- Korean
- Lithuanian

- Polish
- Portuguese
- Romanian
- Russian
- Spanish
- Turkish
- Ukrainian

If you would like to initiate a translation project to an additional language, please report this issue using the "*Report a Problem*" link above or by posting to the mongodb-translators list.

Currently the translation project only publishes rendered translation. While the translation effort is currently focused on the web site we are evaluating how to retrieve the translated phrases for use in other media.

See Also:

- *Contribute to the Documentation* (page 1075)
- *MongoDB Documentation Style and Conventions* (page 1076)
- *MongoDB Documentation Organization* (page 1084)
- *MongoDB Documentation Practices and Processes* (page 1081)
- *Build and Deploy the MongoDB Documentation* (page 1085)

The entire documentation source for this manual is available in the mongodb/docs repository, which is one of the MongoDB project repositories on GitHub.

To contribute to the documentation, you can open a GitHub account, fork the mongodb/docs repository, make a change, and issue a pull request.

In order for the documentation team to accept your change, you must complete the MongoDB/10gen Contributor Agreement.

You can clone the repository by issuing the following command at your system shell:

```
git clone git://github.com/mongodb/docs.git
```

71.2 About the Documentation Process

The MongoDB Manual uses Sphinx, a sophisticated documentation engine built upon Python Docutils. The original reStructured Text files, as well as all necessary Sphinx extensions and build tools, are available in the same repository as the documentation.

For more information on the MongoDB documentation process, see:

71.2.1 MongoDB Documentation Style and Conventions

This document provides an overview of the style for the MongoDB documentation stored in this repository. The overarching goal of this style guide is to provide an accessible base style to ensure that our documentation is easy to read, simple to use, and straightforward to maintain.

For information regarding the MongoDB Manual organization, see *MongoDB Documentation Organization* (page 1084).

Document History

2011-09-27: Document created with a (very) rough list of style guidelines, conventions, and questions.

2012-01-12: Document revised based on slight shifts in practice, and as part of an effort of making it easier for people outside of the documentation team to contribute to documentation.

2012-03-21: Merged in content from the Jargon, and cleaned up style in light of recent experiences.

2012-08-10: Addition to the "Referencing" section.

2013-02-07: Migrated this document to the manual. Added "map-reduce" terminology convention. Other edits.

Naming Conventions

This section contains guidelines on naming files, sections, documents and other document elements.

- File naming Convention:
  - For Sphinx, all files should have a `.txt` extension.
  - Separate words in file names with hyphens (i.e. `-`.)
  - For most documents, file names should have a terse one or two word name that describes the material covered in the document. Allow the path of the file within the document tree to add some of the required context/categorization. For example it's acceptable to have `http://docs.mongodb.org/v2.2/core/sharding.rst` and `http://docs.mongodb.org/v2.2/administration/sharding.rst`.
  - For tutorials, the full title of the document should be in the file name. For example, `http://docs.mongodb.org/v2.2/tutorial/replace-one-configuration-server-in-a-shard-c`
- Phrase headlines and titles so that they the content contained within the section so that users can determine what questions the text will answer, and material that it will address without needing them to read the content. This shortens the amount of time that people spend looking for answers, and improvise search/scanning, and possibly "SEO."
- Prefer titles and headers in the form of "Using foo" over "How to Foo."
- When using target references (i.e. `:ref:` references in documents,) use names that include enough context to be intelligible thought all documentations. For example, use "`replica-set-secondary-only-node`" as opposed to "`secondary-only-node`". This is to make the source more usable and easier to maintain.

Style Guide

This includes the local typesetting, English, grammatical, conventions and preferences that all documents in the manual should use. The goal here is to choose good standards, that are clear, and have a stylistic minimalism that does not interfere with or distract from the content. A uniform style will improve user experience, and minimize the effect of a multi-authored document.

Punctuation

- Use the oxford comma.

  Oxford commas are the commas in a list of things (e.g. "something, something else, and another thing") before the conjunction (e.g. "and" or "or.").

- Do not add two spaces after terminal punctuation, such as periods.

- Place commas and periods inside quotation marks.
- Use title case for headings and document titles. Title case capitalizes the first letter of the first, last, and all significant words.

Verbs

Verb tense and mood preferences, with examples:

- **Avoid** the first person. For example do not say, "We will begin the backup process by locking the database," or "I begin the backup process by locking my database instance,"
- **Use** the second person. "If you need to back up your database, start by locking the database first." In practice, however, it's more concise to imply second person using the imperative, as in "Before inititating a back up, lock the database."
- When indicated, use the imperative mood. For example: "Backup your databases often" and "To prevent data loss, back up your databases."
- The future perfect is also useful in some cases. For example, "Creating disk snapshots without locking the database will lead to an inconsistent state."
- Avoid helper verbs, as possible, to increase clarity and concision. For example, attempt to avoid "this does foo" and "this will do foo" when possible. Use "does foo" over "will do foo" in situations where "this foos" is unacceptable.

Referencing

- To refer to future or planned functionality in MongoDB or a driver, *always* link to the Jira case. The Manual's `conf.py` provides an `:issue:` role that links directly to a Jira case (e.g. `:issue:\`SERVER-9001\``).
- For non-object references (i.e. functions, operators, methods, database commands, settings) always reference only the first occurrence of the reference in a section. You should *always* reference objects, except in section headings.
- Structure references with the *why* first; the link second.

  For example, instead of this:

  Use the *Convert a Replica Set to a Replicated Sharded Cluster* (page 601) procedure if you have an existing replica set.

  Type this:

  To deploy a sharded cluster for an existing replica set, see *Convert a Replica Set to a Replicated Sharded Cluster* (page 601).

General Formulations

- Contractions are acceptable insofar as they are necessary to increase readability and flow. Avoid otherwise.
- Make lists grammatically correct.
  - Do not use a period after every item unless the list item completes the unfinished sentence before the list.
  - Use appropriate commas and conjunctions in the list items.
  - Typically begin a bulleted list with an introductory sentence or clause, with a colon or comma.
- The following terms are one word:

  - standalone
  - workflow

- Use "unavailable," "offline," or "unreachable" to refer to a `mongod` instance that cannot be accessed. Do not use the colloquialism "down."
- Always write out units (e.g. "megabytes") rather than using abbreviations (e.g. "MB".)

Structural Formulations

- There should be at least two headings at every nesting level. Within an "h2" block, there should be either: no "h3" blocks, 2 "h3" blocks, or more than 2 "h3" blocks.
- Section headers are in title case (capitalize first, last, and all important words) and should effectively describe the contents of the section. In a single document you should strive to have section titles that are not redundant and grammatically consistent with each other.
- Use paragraphs and paragraph breaks to increase clarity and flow. Avoid burying critical information in the middle of long paragraphs. Err on the side of shorter paragraphs.
- Prefer shorter sentences to longer sentences. Use complex formations only as a last resort, if at all (e.g. compound complex structures that require semi-colons).
- Avoid paragraphs that consist of single sentences as they often represent a sentence that has unintentionally become too complex or incomplete. However, sometimes such paragraphs are useful for emphasis, summary, or introductions.

  As a corollary, most sections should have multiple paragraphs.
- For longer lists and more complex lists, use bulleted items rather than integrating them inline into a sentence.
- Do not expect that the content of any example (inline or blocked,) will be self explanatory. Even when it feels redundant, make sure that the function and use of every example is clearly described.

ReStructured Text and Typesetting

- Place spaces between nested parentheticals and elements in JavaScript examples. For example, prefer `{ [ a, a, a ] }` over `{[a,a,a]}`.
- For underlines associated with headers in RST, use:
  - = for heading level 1 or h1s. Use underlines and overlines for document titles.
  - − for heading level 2 or h2s.
  - ~ for heading level 3 or h3s.
  - ` for heading level 4 or h4s.
- Use hyphens (−) to indicate items of an ordered list.
- Place footnotes and other references, if you use them, at the end of a section rather than the end of a file.

  Use the footnote format that includes automatic numbering and a target name for ease of use. For instance a footnote tag may look like: `[#note]_` with the corresponding directive holding the body of the footnote that resembles the following: `.. [#note]`.

  Do **not** include `.. code-block:: [language]` in footnotes.

- As it makes sense, use the `.. code-block:: [language]` form to insert literal blocks into the text. While the double colon, `::`, is functional, the `.. code-block:: [language]` form makes the source easier to read and understand.
- For all mentions of referenced types (i.e. commands, operators, expressions, functions, statuses, etc.) use the reference types to ensure uniform formatting and cross-referencing.

Jargon and Common Terms

Database Systems and Processes

- To indicate the entire database system, use "MongoDB," not mongo or Mongo.
- To indicate the database process or a server instance, use `mongod` or `mongos`. Refer to these as "processes" or "instances." Reserve "database" for referring to a database structure, i.e., the structure that holds collections and refers to a group of files on disk.

Distributed System Terms

- Refer to partitioned systems as "sharded clusters." Do not use shard clusters or sharded systems.
- Refer to configurations that run with replication as "replica sets" (or "master/slave deployments") rather than "clusters" or other variants.

Data Structure Terms

- "document" refers to "rows" or "records" in a MongoDB database. Potential confusion with "JSON Documents."

  Do not refer to documents as "objects," because drivers (and MongoDB) do not preserve the order of fields when fetching data. If the order of objects matter, use an array.
- "field" refers to a "key" or "identifier" of data within a MongoDB document.
- "value" refers to the contents of a "field".
- "sub-document" describes a nested document.

Other Terms

- Use `example.net` (and `.org` or `.com` if needed) for all examples and samples.
- Hyphenate "map-reduce" in order to avoid ambiguous reference to the command name. Do not camel-case.

Notes on Specific Features

- Geo-Location
  1. While MongoDB *is capable* of storing coordinates in sub-documents, in practice, users should only store coordinates in arrays. (See: DOCS-41.)

71.2.2 MongoDB Documentation Practices and Processes

This document provides an overview of the practices and processes.

Contents

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Commits

When relevant, include a Jira case identifier in a commit message. Reference documentation cases when applicable, but feel free to reference other cases from jira.mongodb.org.

Err on the side of creating a larger number of discrete commits rather than bundling large set of changes into one commit.

For the sake of consistency, remove trailing whitespaces in the source file.

"Hard wrap" files to between 72 and 80 characters per-line.

Standards and Practices

- At least two people should vet all non-trivial changes to the documentation before publication. One of the reviewers should have significant technical experience with the material covered in the documentation.
- All development and editorial work should transpire on github branches or forks that editors can then merge into the publication branches.

Collaboration

To propose a change to the documentation, do either of the following:

- Open a ticket in the documentation project proposing the change. Someone on the documentation team will make the change and be in contact with you so that you can review the change.
- Using GitHub, fork the mongodb/docs repository, commit your changes, and issue a pull request. Someone on the documentation team will review and incorporate your change into the documentation.

Builds

Building the documentation is useful because Sphinx and docutils can catch numerous errors in the format and syntax of the documentation. Additionally, having access to an example documentation as it *will* appear to the users is useful for providing more effective basis for the review process. Besides Sphinx, Pygments, and Python-Docutils, the documentation repository contains all requirements for building the documentation resource.

Talk to someone on the documentation team if you are having problems running builds yourself.

Publication

The makefile for this repository contains targets that automate the publication process. Use `make html` to publish a test build of the documentation in the `build/` directory of your repository. Use `make publish` to build the full contents of the manual from the current branch in the `../public-docs/` directory relative the docs repository.

Other targets include:

- `man` - builds UNIX Manual pages for all Mongodb utilities.
- `push` - builds and deploys the contents of the `../public-docs/`.
- `pdfs` - builds a PDF version of the manual (requires LaTeX dependencies.)

Branches

This section provides an overview of the git branches in the MongoDB documentation repository and their use.

At the present time, future work transpires in the `master`, with the main publication being `current`. As the documentation stabilizes, the documentation team will begin to maintain branches of the documentation for specific MongoDB releases.

Migration from Legacy Documentation

The MongoDB.org Wiki contains a wealth of information. As the transition to the Manual (i.e. this project and resource) continues, it's *critical* that no information disappears or goes missing. The following process outlines *how* to migrate a wiki page to the manual:

1. Read the relevant sections of the Manual, and see what the new documentation has to offer on a specific topic.

   In this process you should follow cross references and gain an understanding of both the underlying information and how the parts of the new content relates its constituent parts.

2. Read the wiki page you wish to redirect, and take note of all of the factual assertions, examples presented by the wiki page.

3. Test the factual assertions of the wiki page to the greatest extent possible. Ensure that example output is accurate. In the case of commands and reference material, make sure that documented options are accurate.

4. Make corrections to the manual page or pages to reflect any missing pieces of information.

   The target of the redirect need *not* contain every piece of information on the wiki page, **if** the manual as a whole does, and relevant section(s) with the information from the wiki page are accessible from the target of the redirection.

5. As necessary, get these changes reviewed by another writer and/or someone familiar with the area of the information in question.

   At this point, update the relevant Jira case with the target that you've chosen for the redirect, and make the ticket unassigned.

6. When someone has reviewed the changes and published those changes to Manual, you, or preferably someone else on the team, should make a final pass at both pages with fresh eyes and then make the redirect.

   Steps 1-5 should ensure that no information is lost in the migration, and that the final review in step 6 should be trivial to complete.

Review Process

Types of Review

The content in the Manual undergoes many types of review, including the following:

Initial Technical Review Review by an engineer familiar with MongoDB and the topic area of the documentation. This review focuses on technical content, and correctness of the procedures and facts presented, but can improve any aspect of the documentation that may still be lacking. When both the initial technical review and the content review are complete, the piece may be "published."

Content Review Textual review by another writer to ensure stylistic consistency with the rest of the manual. Depending on the content, this may precede or follow the initial technical review. When both the initial technical review and the content review are complete, the piece may be "published."

Consistency Review This occurs post-publication and is content focused. The goals of consistency reviews are to increase the internal consistency of the documentation as a whole. Insert relevant cross-references, update the style as needed, and provide background fact-checking.

When possible, consistency reviews should be as systematic as possible and we should avoid encouraging stylistic and information drift by editing only small sections at a time.

Subsequent Technical Review If the documentation needs to be updated following a change in functionality of the server or following the resolution of a user issue, changes may be significant enough to warrant additional technical review. These reviews follow the same form as the "initial technical review," but is often less involved and covers a smaller area.

Review Methods

If you're not a usual contributor to the documentation and would like to review something, you can submit reviews in any of the following methods:

- If you're reviewing an open pull request in GitHub, the best way to comment is on the "overview diff," which you can find by clicking on the "diff" button in the upper left portion of the screen. You can also use the following URL to reach this interface:

  ```
  https://github.com/mongodb/docs/pull/[pull-request-id]/files
  ```

  Replace `[pull-request-id]` with the identifier of the pull request. Make all comments inline, using GitHub's comment system.

  You may also provide comments directly on commits, or on the pull request itself but these commit-comments are archived in less coherent ways and generate less useful emails, while comments on the pull request lead to less specific changes to the document. '

- Leave feedback on Jira cases in the DOCS project. These are better for more general changes that aren't necessarily tied to a specific line, or affect multiple files.

- Create a fork of the repository in your GitHub account, make any required changes and then create a pull request with your changes.

  If you insert lines that begin with any of the following annotations:

  ```
  .. TODO:
  TODO:
  .. TODO
  TODO
  ```

  followed by your comments, it will be easier for the original writer to locate your comments. The two dots `..` format is a comment in reStructured Text, which will hide your comments from Sphinx and publication if you're worried about that.

  This format is often easier for reviewers with larger portions of content to review.

71.2.3 MongoDB Documentation Organization

This document provides an overview of the global organization of the documentation resource. Refer to the notes below if you are having trouble understanding the reasoning behind a file's current location, or if you want to add new documentation but aren't sure how to integrate it into the existing resource.

If you have questions, don't hesitate to open a ticket in the Documentation Jira Project or contact the documentation team.

Global Organization

Indexes and Experience

The documentation project has two "index files": `http://docs.mongodb.org/v2.2/contents.txt` and `http://docs.mongodb.org/v2.2/index.txt`. The "contents" file provides the documentation's tree structure, which Sphinx uses to create the left-pane navigational structure, to power the "Next" and "Previous" page functionality, and to provide all overarching outlines of the resource. The "index" file is not included in the "contents" file (and thus builds will produce a warning here) and is the page that users first land on when visiting the resource.

Having separate "contents" and "index" files provides a bit more flexibility with the organization of the resource while also making it possible to customize the primary user experience.

Additionally, in the top level of the `source/` directory, there are a number of "topical" index or outline files. These (like the "index" and "contents" files) use the `..  toctree::` directive to provide organization within the documentation. The topical indexes combine to create the index in the contents file.

Topical Indexes and Meta Organization

Because the documentation on any given subject exists in a number of different locations across the resource the "topical" indexes provide the real structure and organization to the resource. This organization makes it possible to provide great flexibility while still maintaining a reasonable organization of files and URLs for the documentation. Consider the following example:

> Given that topic such as "replication," has material regarding the administration of replica sets, as well as reference material, an overview of the functionality, and operational tutorials, it makes more sense to include a few locations for documents, and use the meta documents to provide the topic-level organization.

Current topical indexes include:

- getting-started

- administration
- applications
- reference
- mongo
- sharding
- replication
- faq

Additional topical indexes are forthcoming.

The Top Level Folders

The documentation has a number of top-level folders, that hold all of the content of the resource. Consider the following list and explanations below:

- "administration" - contains all of the operational and architectural information that systems and database administrators need to know in order to run MongoDB. Topics include: monitoring, replica sets, shard clusters, deployment architectures, and configuration.
- "applications" - contains information about application development and use. While most documentation regarding application development is within the purview of the driver documentation, there are some larger topics regarding the use of these features that deserve some coverage in this context. Topics include: drivers, schema design, optimization, replication, and sharding.
  - "applications/use-cases" - contains use cases that detail how MongoDB can support various kinds uses and application designs, including in depth instructions and examples.
- "core" - contains overviews and introduction to the core features, functionality, and concepts of MongoDB. Topics include: replication, sharding, capped collections, journaling/durability, aggregation.
- "reference" - contains references and indexes of shell functions, database commands, status outputs, as well as manual pages for all of the programs come with MongoDB (e.g. `mongostat` and `mongodump`.)
- "tutorial" - contains operational guides and tutorials that lead users through common tasks (administrative and conceptual) with MongoDB. This includes programming patterns and operational guides.
- "faq" - contains all the frequently asked questions related to MongoDB, in a collection of topical files.

71.2.4 Build and Deploy the MongoDB Documentation

This document contains more direct instructions for building the MongoDB documentation.

Requirements

For basic publication and testing:

- GNU Make
- Python
- Git
- Sphinx (documentation management toolchain)
- Pygments (syntax highlighting)

- PyYAML (for the generated tables)

For full publication builds:

- python-argparse
- LaTeX/PDF LaTeX (typically texlive; for building PDFs)
- Common Utilities (rsync, tar, gzip, sed)

Building the Documentation

Clone the repository:

```
git clone git://github.com/mongodb/docs.git
```

To build the full publication version of the manual, you will need to have a function LaTeX tool chain; however, for routine day-to-day rendering of the documentation you can install a much more minimal tool chain.

For Routine Builds

Begin by installing dependencies. On Arch Linux, use the following command to install the full dependencies:

```
pacman -S python2-sphinx python2-pygments python2-yaml
```

On Debian/Ubuntu systems issue the following command:

```
apt-get install python-sphinx python-yaml python-argparse
```

To build the documentation issue the following command:

```
make html
```

You can find the build output in `build/<branch>/html`, where `<branch>` is the name of your current branch.

For Publication Builds

Begin by installing additional dependencies. On Arch Linux, use the following command to install the full dependencies:

```
pacman -S python2-sphinx python2-pygments python2-yaml \
          texlive-bin texlive-core texlive-latexextra
```

On Debian/Ubuntu systems use the following command:

```
apt-get install python-yaml python-argparse python-sphinx \
                texlive-latex-recommended texlive-latex-recommended
```

Note: *The Debian/Ubuntu dependencies, have not been thoroughly tested. If you find an additional dependency, please submit a pull request to modify this document.*

On OS X:

1. You may need to use `easy_install` to install `pip` using the following command if you have not already done so:

   ```
   easy_install pip
   ```

   Alternately, you may be able to replace `pip` with `easy_install` in the next step.

2. Install Sphinx, Docutils, and their dependencies with `pip` using the following command:

   ```
   pip install Sphinx Jinja2 Pygments docutils  PyYAML
   ```

   `Jinja2`, `Pygments`, and `docutils` are all dependencies of `Sphinx`.

   Note: As of June 6, 2012 and Sphinx version 1.1.3, you **must** compile the MongoDB documentation using the Python 2.x series version of Sphinx. There are serious generation problems with the Python 3 series version of Sphinx.

   ---

3. Install a TeX distribution (for building the PDF.) If you do not have a LaTeX installation, use MacTeX

If you have any corrections to the instructions for these platforms or you have a dependency list for Fedora, CentOS, Red Hat, or other related distributions, please submit a pull request to add this information to this document.

To build a test version of the Manual, issue the following command:

```
make publish
```

This places a complete version of the manual in "`../public-docs/`" named for the current branch (as of *2012-03-19*, typically master.)

To publish a new build of the manual, issue the following command:

```
make push
```

Warning: *This target depends on* `publish`*, and simply uses* `rsync` *to move the content of the "*`../public-docs/`*" to the web servers. You must have the proper credentials to run these operations.*

Run `publish` *procedure and thoroughly test the build before pushing it live.*

Troubleshooting

If you encounter problems with the build, please contact the docs team, so that we can update this guide and/or fix the build process.

Build Components and Internals

This section describes the build system for the MongoDB manual, including the custom components, and the organization of the production build process, and the implementation and encoding of the build process.

Tables

`bin/table_builder.py` provides a way to generate easy to main reStructuredText tables, from content stored in YAML files.

Rationale: reStructuredText's default tables are easy to read in source format, but expensive to maintain, particularly with larger numbers of columns, because changing widths of column necessitates reformatting the entire table. reStructuredText does provide a more simple "list table" format for simple tables, but these tables do not support more complex multi-line output.

Solution: `table_builder.py` reads a `.yaml` file that contains three documents:

(*Each document has a ''section'' field that holds the name/type of the section, that ''table_builder.py'' uses to ensure that the YAML file is well formed.*)

1. A `layout` document that describes the structure the final presentation of the table. Contains two field, a `header` that holds a list of field references, and a `rows` field that holds a list of lists of field references, for example:

   ```
   section: layout
   header: [ meta.header1, meta.header2 ]
   rows:
     - 1: [ content.sql1, content.mongo1 ]
     - 2: [ content.sql2, content.mongo2 ]
     - 3: [ content.sql3, content.mongo3 ]
     - 4: [ content.sql4, content.mongo4 ]
   ```

2. A `meta` document that holds row, column or other minor descriptions, referenced in the layout section.

3. A `content` document that holds the major content of the document.

There is no functional difference between `meta` and `content` fields except that they each provide a distinct namespace for table content.

`table_builder.py` generates `.rst` output files from `.yaml` files. The documents processed by Sphinx use the `.. include::` reStructureText directive to include the `.rst` file. The build system includes targets (generated,) for all tables, which are a dependency of the Sphinx build process. [1]

Use: To add a table:

- create an appropriate `.yaml` file using any of the existing files as an example. The build system generates all table files in the `source/includes/` directory with the `.yaml` extension that begin with `table-`.
- include the generated `.rst` file in your Sphinx document. (Optional.)

Generated Makefiles

System While the `makefile` in the top level of documentation source coordinates the build process, most of the build targets and build system exist in the form of makefiles generated by a collection of Python scripts. This architecture reduces redundancy while increasing clarity and consistency.

These makefiles enter the build process by way of include statements and a pattern rule in `bin/makefile.dynamic`, as follows:

```
-include $(output)/makefile.tables
-include $(output)/makefile.sphinx

$(output)/makefile.%:bin/makefile-builder/%.py bin/makefile_builder.py bin/builder_data.py
        @$(PYTHONBIN) bin/makefile-builder/$(subst .,,$(suffix $@)).py $@
```

This will rebuild any of the include files that match the pattern `$(output)/makefile.%`, if the corresponding python script changes, *or* it will rebuild all generated makefiles if the `builder_data.py` or the `makefile_builder.py` files change.

The Python scripts that output these makefiles, all use the `MakefileBuilder` class in the `makefile_builder.py` file, and are all located in the `bin/makefile-builder/` directory. Consider a simplified example Python code:

```
from makefile_builder import MakefileBuilder
from builder_data import sphinx
```

[1] To prevent a build error, tables are a dependency of all Sphinx builds *except* the `dirhtml`, `singlehtml`, and `latex` builds, which run concurrently during the production build process. If you change tables, and run any of these targets without building the `tables` target, you the table will not refresh.

```
m = MakefileBuilder()

m.section_break('sphinx targets', block='sphinx')
m.comment('each sphinx target invokes and controls the sphinx build.', block='sphinx')
m.newline(block='sphinx')

for (builder, prod) in sphinx:
    m.newline(1, builder)
    m.append_var('sphinx-targets', builder)

    if prod is True and builder != 'epub':
        b = 'production'
        m.target(builder, block=b)
    else:
        b = 'testing'
        m.target(builder, 'sphinx-prerequisites', block=b)

    m.job('mkdir -p $(branch-output)/' + builder, block=b)
    m.msg('[$@]: created $(branch-output)/' + builder, block=b)
    m.msg('[sphinx]: starting $@ build', block=b)
    m.msg('[$@]: build started at `date`.', block=b)
    m.job('$(SPHINXBUILD) -b $@ $(ALLSPHINXOPTS) $(branch-output)/$@', block=b)

m.write('makefile.output-filename')
```

You can also call `m.print_content()` to render the makefile to standard output. See `makefile_builder.py` for the more methods that you can use to define makefiles. This code will generate a makefile that resembles the following:

```
sphinx-targets += epub
epub:sphinx-prerequisites
        @mkdir -p $(branch-output)/epub
        @echo [$@]: created $(branch-output)/epub
        @echo [sphinx]: starting $@ build
        @echo [$@]: build started at `date`.
        @$(SPHINXBUILD) -b $@ $(ALLSPHINXOPTS) $(branch-output)/$@

sphinx-targets += html
html:sphinx-prerequisites
        @mkdir -p $(branch-output)/html
        @echo [$@]: created $(branch-output)/html
        @echo [sphinx]: starting $@ build
        @echo [$@]: build started at `date`.
        @$(SPHINXBUILD) -b $@ $(ALLSPHINXOPTS) $(branch-output)/$@

sphinx-targets += gettext
gettext:sphinx-prerequisites
        @mkdir -p $(branch-output)/gettext
        @echo [$@]: created $(branch-output)/gettext
        @echo [sphinx]: starting $@ build
        @echo [$@]: build started at `date`.
        @$(SPHINXBUILD) -b $@ $(ALLSPHINXOPTS) $(branch-output)/$@
```

All information about the targets themselves are in the `builder_data.py` file, that contains a number of variables that hold lists of tuples with information used by the Python scripts to generate the build rules. Comments explain the structure of the data in `builder_data.py`.

System The build system contains the following 8 makefiles:

- *pdfs*: Encodes the process for transforming Sphinx's LaTeX output into pdfs.
- *tables*: Describes the process for building all tables generated using `table_builder.py`.
- *links*: Creates the symbolic links required for production builds.
- *sphinx*: Generates the targets for Sphinx. These are mostly, but not entirely consistent with the default targets provided by Sphinx itself.
- *releases*: Describe targets for generating files for inclusion in the installation have the versions of MongoDB automatically baked into the their text.
- *errors*: Special processing of the HTTP error pages.
- *migrations*: Describes the migration process for all non-sphinx components of the build.
- *sphinx-migrations*: Ensures that all sphinx migrations are fresh.

Troubleshooting If you experience an issue with the generated makefiles, the generated files have comments, and are quite human readable. To add new generated targets or makefiles, experiment first writing makefiles themselves, and then write scripts to generate the makefiles.

Because the generated makefiles, and indeed most of the build process does not echo commands, use `make -n` to determine the actual oration and sequence used in the build process.

If you have any questions, please feel free to open a Jira Case.