

Ingres® 2006 Release 2

Migration Guide

INGRES®

February 2007

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Chapter 1: Planning the Upgrade

This guide, when used with the other guides in the Ingres® documentation set, will assist in the planning and execution of a successful upgrade of Ingres.

After the upgrade is complete and running successfully for a suitable period, you can consider using the new features. The new features for the current release are described in the *Release Summary*, while the new features for past releases are described in appendixes in this *Migration Guide*.

This chapter describes how to plan for the upgrade, methods of upgrading, considerations for specific Ingres releases, required installations and hardware when upgrading, overall strategy for the upgrade, and application issues.

The Upgrade Plan

The key to a successful upgrade is to prepare a detailed plan. A detailed plan can prevent problems when upgrading. The plan should include items such as how long it will take to complete a backup and how to verify that the data is complete and secure.

The plan should then be tested, preferably with a copy of the production system data. Testing reveals areas that may cause problems during the upgrade of the production system.

You should then implement the plan, but **only** after preliminary testing is complete.

The best strategy for upgrading is to first implement any compatibility fixes in the current environment. When the databases and applications are ready, test them in that environment, practice the upgrade, and then perform the upgrade.

Do not use any new features until the upgrade is successfully implemented. Doing so keeps to a minimum the number of variables at each step.

Upgrade Types

There are two options for upgrading your production systems:

- The upgradedb utility
- The unload/reload method

You can mix the two upgrade types, upgrading some databases while reloading others.

Upgradedb Method

The upgradedb utility allows for a fast, in-place upgrade path for an older version Ingres database, with no additional disk space requirements. Because upgradedb is faster, it is typically the recommended way of upgrading.

Preparing for a safe and reliable upgradedb, however, can take time, especially when upgrading from Ingres 6.4.

Databases using the system-maintained logical key feature are best upgraded using upgradedb. Tables that contain SYSTEM_MAINTAINED table_key or object_key columns cannot be safely unloaded and reloaded without additional work. The reload step generates all new logical key values. If there are other tables referencing the logical key columns, the new values must somehow be manually propagated to those other tables.

Unload/Reload Method

The database unload/reload method ensures a clean start with a fresh database. Depending on the kind of table data, additional disk space may be needed to perform the unloading and reloading; the space could be as large as three to five times the space of the database that is to be upgraded. For example, compressed tables with wide char or varchar columns can expand substantially when unloaded.

The unload/reload process takes longer than `upgradedb`, thus increasing the downtime of the production system. However, it ensures a clean final installation.

A database that has been running for years, perhaps surviving a number of system crashes and hardware failures, may have suffered hidden damage that can confuse the `upgradedb` utility. For example, a database that is used by a small department or group of people may not be maintained as well as a production database. Such a database may have work tables owned by a user who no longer exists, or may be missing table data files. An unload/reload upgrade may be a better choice for this database.

The typical unload/reload upgrade uses the original Ingres installation as a base. The system databases `iidbdb` and `imadb` are upgraded in-place with `upgradedb`, even if user databases are unloaded/reloaded. A variation of the unload/reload method uses a brand new installation (perhaps even on a different machine). When this is done, additional work is needed to transfer `iidbdb` information (users, groups, roles, and database and installation privileges) to the new installation.

Upgrade Method and Ingres Releases

The release of Ingres that you are upgrading from can affect the type of upgrade you choose.

From Releases Prior to Ingres 6.4

If you are upgrading from a version of Ingres prior to release 6.4, you must use an unload/reload upgrade. Furthermore, you must install Ingres into a new, fresh installation; the original installation cannot be upgraded in-place.

From Ingres 6.4

If you are upgrading from Ingres 6.4, you can use either the `upgradedb` or the unload/reload method.

Ingres 2006 provides an improved `upgradedb` utility that allows 6.4 databases to be upgraded with minimal database preparation effort. You can follow the standard `upgradedb` procedure described in the chapter “Upgrading Using `Upgradedb`.”

Since most 6.4 databases are several years old, you may choose to use an unload/reload upgrade. Keep in mind that an unload/reload upgrade takes substantially more time and resources. If you choose the unload/reload method, follow the procedures in Unload/Reload Procedure for Upgrading from 6.4 (see page 84).

Regardless of the method chosen, however, an upgrade from Ingres 6.4 requires more planning and preparation than upgrades from newer versions, and you must follow the application and system preparation procedures described in Considerations for Ingres 6.4 (see page 79).

An alternative `upgradedb` procedure that requires extensive preparation, but will result in a successful upgrade under almost any circumstances, is described in Alternate Upgrade Procedure (see page 96).

From Releases Newer than Ingres 6.4

When upgrading from OpenIngres 1.2 or 2.0, Ingres II 2.0 or 2.5, or Ingres 2.6, we recommend the `upgradedb` method. The upgrade is internally much simpler than the upgrade from 6.4. In addition, there are fewer application-level incompatibilities among newer versions.

An unload/reload upgrade is possible, but is slower and requires more disk space than an `upgradedb` upgrade.

OpenIngres 1.2: If you are starting with OpenIngres 1.2, any tables having long varchar, long binary, or long spatial data must be unloaded under 1.x and reloaded into Ingres 2.6. The format of the blob extension tables has changed. The remainder of the database can be upgraded with `upgradedb`; however, it is probably simplest to use a full unload/reload upgrade with any databases containing “long” datatypes.

From a 32-bit to a 64-bit Release

You can upgrade your 32-bit Ingres database for use with 64-bit Ingres by running the `upgradedb` utility. The 32-bit to 64-bit database conversion process redefines views, rules, integrities, and QUEL permits. The data in user tables is **not** affected by the 32-bit to 64-bit upgrade.

The `upgradedb` program does the following:

- Redefines the standard catalog views (iitables, iicolumns, and so on)
- Generates an SQL script to drop and redefine views, rules, integrities, and QUEL permits
- Executes the SQL script

The generated SQL scripts, and the SQL output, can be found in the directory `$II_SYSTEM/ingres/files/upgradedb/UPGRADEUSER` (where `UPGRADEUSER` is the user who is running the `upgradedb` program). There will be files `DBNAME.i01` (SQL input) and `DBNAME.o01` (SQL output). Depending on the specifics of the database, there might also be files `DBNAME.g01` (grant inputs) and `DBNAME.go01` (grant SQL output), and files `DBNAME.r01` (referential constraint input) and `DBNAME.ro01` (referential constraint output).

If your database contains an object that cannot be redefined, the `upgradedb` may fail to redefine all objects. You can use the SQL script and output in `$II_SYSTEM/ingres/files/upgradedb` to determine the point of failure. If necessary, contact customer support for assistance.

To Member-Aligned Alpha OpenVMS (axm.vms)

If you are using OpenVMS on Alpha hardware, and are upgrading to the member-aligned version of Ingres (`axm.vms`) from a non-member-aligned version (`axp.vms`), you must use `unload/reload`. `Upgradedb` is not available due to shifts in table data positions caused by the new alignment. For instructions, see the chapter "Considerations for Alpha OpenVMS."

Required Installations for Upgrading

For a safe and orderly upgrade, at least four Ingres installations are needed:

- Original version production installation
- Original version development installation
- Installation for testing the upgrade
- New version development installation for preparing and testing applications

If possible, keep the installations away from the production machine. You may temporarily need additional hardware to accommodate the required installations during the upgrade.

Possible Hardware Setups for Upgrading

Possible hardware setups are from one to four machines.

A four-machine setup can be used, with each installation on its own machine. More commonly, however, the two development installations share a machine. Because there is usually some traffic between these two installations during preparation, sharing a machine is convenient.

Note: If you are using Windows, you need a separate machine for each installation. Versions prior to Ingres 2.6 do not support multiple installations on one Windows machine.

A three-machine setup is the recommended minimum, as follows:

- Development (both old and new versions)
- Test
- Production

A two-machine setup is possible, as follows:

- Development (possibly including a test installation)
- Production

The two-machine setup is not recommended because the test installation shares a machine with development, so it will not mimic your production installation as closely. In addition, the more installations on a machine, the more chance for error.

A single machine setup is possible, but not recommended, since you may accidentally work in the wrong installation and damage production.

Note: There is no remote installation procedure for Ingres. The machine must have local media support (CD-ROM or tape); otherwise, you will have to copy the distribution files from wherever the CD-ROM or tape drive is situated.

How You Perform the Upgrade

Note: Back up all data before starting.

The overall strategy for upgrading is as follows:

1. Copy databases and applications.

Copy the databases to be upgraded into the new version development installation, and make a copy of all associated applications.

It is important that your original version development installation remain; if the upgrade is unpredictably delayed, you will still have your original environment in which to fix mission-critical applications, if necessary.

2. Change databases and applications.

Make any changes needed to the database definition or the application source code so that they function with the new version.

If you are upgrading from a recent version (for example, from Ingres II 2.0 to Ingres 2.6), few or no changes are necessary. If you are upgrading from Ingres 6.4, this step can be lengthy.

All compatibility changes will be reflected back into the original version development installation. Thus, if the upgrade is delayed for some reason, no work will be lost.

3. Test applications.

Test your critical applications in the new-version development environment.

Fix any problems or performance issues before your production upgrade. The fix will nearly always be compatible with your original version as well, and therefore can be reflected back into your standard development environment.

4. Practice the upgrade.

Practice the upgrade using the test installation. Ideally, the test installation should be a duplicate of production. Repeat the trial upgrade as often as necessary to achieve a trouble-free upgrade.

Note: While practicing the upgrade, stop application development. You want the live upgrade to run exactly like the practice one, without involving new and untested factors.

5. Upgrade to the production system.

How You Plan for Application Issues

To ensure your applications can be tested in the new installation, do the following:

- Before starting the upgrade, take an application and database inventory. You must have the complete and current source code for all applications. If the source code does not match what users are running, problems can result.
- Make sure that each application can be rebuilt from the source code because you will eventually recompile your applications under the new version.
- If an application cannot be rebuilt, test the original executable under Ingres as soon as possible. If the application has no upward compatibility issues (for example, reserved words), it may be possible to run the old application against an Ingres installation and database. Otherwise, you will have to recreate the application or do without it.
- Try to synchronize the test and live Ingres upgrades with an appropriate time in the application life cycle.

If application development is underway, plan how to coordinate new development with Ingres compatibility. Upgrades from newer versions (OpenIngres 1.2 or newer) may be able to move quickly enough to avoid the issue. Preparing an upgrade from Ingres 6.4 can take long enough to rule out a full stop in development.

One site, for example, addressed the timing issue by synchronizing Ingres compatibility with a code release. Then, the development installation was converted to Ingres, while an Ingres 6.4 “bug fix” installation was maintained on a different machine.

The Test Plan for Applications

You must test your applications with the new version of Ingres before performing a production upgrade. The cost of testing every function in every application can be prohibitive, but fortunately, such testing is rarely necessary. A proper test plan can reduce testing time to a week or two.

A successful test plan uses the following process:

1. Rank the importance of each function in each application.
2. Test only the most important functions of each application.
3. Fix problems found after the upgrade as quickly as possible.

Categories of Application Functions

When determining the importance of an application function, ask “How long can we live without this function?” One successful testing approach divides application functions into three categories, as follows:

- Functions that are business critical, and must be operational immediately after the upgrade. No delay is permitted. Examples may include customer order entry, shipping, and production order release functions.

Functions in this category must be tested thoroughly.

- Functions that are important, but the business can survive their loss for a few hours after the upgrade. Examples may include most inquiries and accounting functions, and high-visibility management reports, especially if management is made aware of the possibility of a one-time delay.

Functions in this category should be tested as time and resources permit.

- Functions that can be broken for a day or two without serious impact. Examples may include reports, analysis functions, and end-of-period routines.

Functions in this category can typically be spot checked.

Application Debugging After the Upgrade

If you properly execute your test plan, all critical functions will work after the upgrade. Less critical functions, however, may contain bugs. Be prepared to fix these bugs for a period after the upgrade. (Two weeks is usually long enough.) During this time, avoid scheduling new feature development. Have streamlined change control procedures ready, so that fixes can be installed quickly if a problem occurs.

Binary Level Support

Ingres 2006 provides support for applications built against previous versions of Ingres, back to and including Ingres 6.4.

You can run applications built with any version of OpenIngres 1.x or Ingres II 2.x, accessing an Ingres 2006 server, without rebuilding the application.

Applications built against Ingres 6.4 expect to access an older version of the Ingres message files. You can run applications built with Ingres 6.4 against an Ingres 2006 server, as long as either the application is running across Ingres Net, or Ingres 2006 was installed with the 6.4 message files. However, in all cases, we recommend that you rebuild all applications with Ingres 2006.

Chapter 2: Creating a New Ingres Development Environment

This chapter describes how to move your existing development installation into a new Ingres development installation, where you can test your databases and applications and make any necessary changes to ensure that they work correctly.

The goal is to test thoroughly in the new development environment so that you can confidently perform the upgrade to the production system. The upgrade to the production system is described in subsequent chapters.

Note: If you are migrating from Ingres 6.4, read Considerations for Ingres 6.4 (see page 79) before performing the tasks in this chapter.

Platform-specific Examples in This Guide

While most of the examples used in this guide are specific to UNIX, the concepts described also apply to the Windows environment. For information on upgrading in the VMS environment, see the appendix "Considerations for Alpha OpenVMS."

How You Move an Existing Development Installation into the New Development Installation

Note: Back up all data before starting.

The overall process for moving your existing development installation into a new Ingres development installation is as follows:

1. Create a development installation of the new Ingres.
2. Prepare your applications.
3. Load databases and applications into the new installation.
4. Prepare your system.
5. Test applications and procedures.
6. Practice the upgrade.

Create a Development Installation of the New Ingres

To install Ingres on the development machine, following these steps.

Note: The following procedure assumes that the development computer will support both the original and new version Ingres installations.

UNIX:

1. Create a new Ingres directory in a location with sufficient disk space. In this example, the directory is called /ing2006/ingres.

Execute the following commands:

```
mkdir /ing2006/ingres
chmod 755 /ing2006/ingre
```

2. Set the environment to the original and new development installations. To do this, create two scripts. In this example, the scripts are named "setold" and "setnew."

Here are example scripts for the C shell. You may need to adjust them for your specific installation.

For example, the PATH settings may be different, and LD_LIBRARY_PATH may be named LIBPATH or SHLIB_PATH, depending on the platform. In this example, the "old" installation is an Ingres 6.4 installation.

```
setold:
setenv II_SYSTEM /ing64
set path=(. /usr/local/bin /bin /usr/ucb /usr/sbin /usr/openwin/bin
$II_SYSTEM/ingres/bin $II_SYSTEM/Ingres/utility /usr/ccs/bin)
set inst=`ingprenv1 II_INSTALLATION`
setenv LD_LIBRARY_PATH /usr/lib:/usr/openwin/lib
set prompt=`whoami`.`uname -n`[$inst]% "
echo "Switching to original Ingres 6.4 [$inst] installation"

setnew:
setenv II_SYSTEM /ing2006
set path=(. /usr/local/bin /bin /usr/ucb /usr/sbin /usr/openwin/bin
$II_SYSTEM/ingres/bin $II_SYSTEM/ingres/utility /usr/ccs/bin)
set inst=`ingprenv II_INSTALLATION`
setenv LD_LIBRARY_PATH /usr/lib:/usr/openwin/lib:$II_SYSTEM/ingres/lib
set prompt=`whoami`.`uname -n`[$inst]% "
echo "Switching to new 2006 [$inst] installation"
```

3. If required, define aliases in the C shell or shell functions in the Bourne or Korn shell to invoke the setold and setnew scripts.

For example:

```
alias setold source ~ingres/setold
alias setnew source ~ingres/setnew
```

4. Use the “setnew” alias to switch to the new Ingres environment, and change directory to \$II_SYSTEM/ingres.
5. Follow the installation instructions to install Ingres.

Note: Do not use the same data, checkpoint, journal, dump, or log directories as the original installation; the directories can, however, be on the same disks. ■

How You Prepare Your Applications

When moving a copy of applications and databases to the new Ingres installation, you must do the following:

- Check for new reserved words.
- Re-image ABF applications if upgrading to Ingres 2006.
- Check for Report-Writer syntax change, if upgrading from Ingres 6.4.
- Examine procedures that use DATE column definitions if you are using the ANSIDATE data type, if upgrading to Ingres 2006 Release 2.

Reserved Keyword Conflicts

A database cannot be built on an Ingres installation until reserved keyword conflicts are corrected.

Check for and fix reserved word conflicts. Also, check for reserved word conflicts in application code, specifically in dynamically created tables and views.

The additional reserved keywords in Ingres are mostly to support additions to SQL. If words like *level*, *key*, or *comment* are used as column names, you must change them.

The SQL parser recognizes most reserved keywords from context, and usually resolves keyword conflicts without error, so you may not have to change reserved words used as names. If time permits, however, we recommend that you avoid SQL reserved words.

For a complete list of reserved words, see the appendix “Keywords.”

Re-image ABF Applications

In Ingres 2006, the data descriptor used throughout the Ingres system changed because of the introduction of the column-level collation specification feature. This data descriptor is also compiled into imaged Applications-By-Forms (ABF) applications.

After upgrading, all ABF applications should be re-imaged. Delete the contents of the ABF object directory, `$ING_ABFDIR/database-name/app-name`, and then re-image.

Report-Writer Syntax Change When Upgrading from Ingres 6.4

When upgrading from 6.4, to support new Report-Writer syntax, a space is required after all dot-commands. For example, “.NL3” must be changed to “.NL 3”.

UNIX: To fix such occurrences automatically, you can use the following “sed” commands:

```
sed -e 's/\([<space><tab>]\.[a-zA-Z][a-zA-Z]*\)\([0-9]\)/\1 \2/' foo.rw | \
sed -e 's/^\([a-zA-Z][a-zA-Z]*\)\([0-9]\)/\1 \2/' >newfoo.rw
```

Compare the old and new files (foo.rw and newfoo.rw) to ensure that only the expected changes occurred. For example, you want to avoid an unwanted “fix” to a literal string.

An alternative to altering Report-Writer files is to **sreport** them into a database, then **copyrep** the reports back out.

Report-Writer Runtime Parameter Errors (UNIX)

If string parameters that contain quotes are passed to Report-Writer, runtime errors may occur. These errors may be caused by a change to the UNIX command parameter control file `utexe.def`.

If such an error occurs, you can change the command parameter back to the Ingres 6.4 `utexe.def` settings (see page 25). After saving the changed file, retest and see whether the error still occurs.

This problem only occurs with application systems developed under Ingres 6.4. However, you may need to check for the problem even if you are upgrading from a more recent version. Generally, the `utexe.def` file is replaced with every release of Ingres. Therefore, even if you have resolved this issue during a prior upgrade, you will have to check for it again each time you upgrade.

Change Command Parameter Back to Ingres 6.4 utexe.def Settings

To change the command parameter back to the Ingres 6.4 utexe.def settings:

1. Edit \$II_SYSTEM/ingres/files/utexe.def.
2. Search for the string "%S".
3. Change the string to: param '%S'.
4. Save the file.

Use of the ANSIDATE Data Type

As of Ingres 2006 Release 2, the ANSI date and time data types DATE, TIME, TIMESTAMP, and INTERVAL are supported. In previous releases, Ingres supported one date data type that could store dates, times, intervals, and time stamps. The previous date type is renamed to INGRESDATE.

The configuration parameter date_type_alias controls whether the keyword DATE used for column data type refers to INGRESDATE or ANSIDATE data type. If this parameter is not set then the DATE keyword cannot be used in SQL statements.

When migrating from an earlier version of Ingres, the existing date data in the database is not affected. The data is still a valid INGRESDATE data type.

If you use the new date format (ANSIDATE), existing scripts and database procedures with the old DATE column definitions may need to be changed.

Note: When installing or upgrading Ingres using a non interactive install and no value for II_DATE_TYPE_ALIAS is provided in the response file, the value defaults to INGRESDATE.

How You Load Databases and Applications into the New Installation

After you create a development installation of the new Ingres and prepare your applications, you are ready to move your databases into the new development environment.

This process consists of the following steps:

1. Creating users
2. Moving databases
3. Moving catalogs
4. Moving Ingres Star databases
5. Compiling applications in the new environment

Create Users

After your new Ingres development installation is running, create any necessary Ingres users there. You may not need every user that exists in your current development environment. At a minimum, you must create any DBA (database owner) users.

Move Databases

Note: Before performing this task, you should have already created procedures for switching between the original version and new version development environments, as described in *Create a Development Installation of the New Ingres* (see page 22).

To move a database from the original development environment to your new Ingres environment, use a simplified unload/reload procedure, as follows:

1. **Setold** and **cd** to a directory with enough space to hold the data; allow for the Ingres System catalogs.
2. Create a directory for each database that is to be exported.
3. **Cd** to the directory for the database that is to be exported.
4. Execute `unloaddb` against the original-version database to be unloaded.
5. Execute `unload.ing` to export the front-end catalogs and data.
6. Edit the unload scripts as follows:

From Ingres 6.4: Edit the `cp_ingre.in` file and remove the lines:

```
\include /ing64/ingres/files/iiud.scr
\include /ing64/ingres/files/iiud64.scr
```

Directory paths may be different.

From Ingres 1.2: Edit the `copy.in` file and remove the lines:

```
\include /ing12/ingres/files/iiud.scr
\include /ing12/ingres/files/iiud65.scr
```

Directory paths may be different.

7. Fix the *system_maintained* column name (see page 29) if necessary.
8. **Setnew** to the Ingres installation.
9. Create the database there, without any front-end catalogs, as follows:

```
createdb databasename -f nofeclients
```
10. If the Ingres database name is not the same as the original database name, then edit the `reload.ing` script.
11. Execute `reload.ing` for that database.

Note: Capture the output of the reload script (see page 28) in case errors occur.

12. Review the output of the reload for any reserved word conflicts. Correct any problems in the original-version environment and try again.

Capture Output of Reload Script (UNIX)

On UNIX, to capture the output of the reload script to a file, use “tee,” as follows:

```
reload.ing |& tee /temp/reload.log
```

Move Catalogs

At this point, the front-end catalogs in the Ingres database are in the original-version format. To put them into new-version format, run:

```
upgradefe <dbname> INGRES
```

The above command assumes that you want the catalogs *and data* to be copied from the original development database to Ingres. If the data is not wanted, you can edit the scripts so that `unloaddb` does not copy certain tables.

Move Ingres Star Databases

For Ingres Star databases, **unloaddb** the CDB (the coordinator database, which usually starts with `ii`). This process unloads any locally stored tables that do not exist in other local databases.

Then **unloaddb** on the DDB (the distributed database, usually accessed by `ddbname/star`). This process unloads registrations and distributed view definitions.

The `system_maintained` Column Name

Databases created in releases prior to Ingres II 2.5 that contain the Metaschema module of system catalogs require an additional task when upgrading to Ingres II 2.5 using unload/reload.

These databases contain an extended system catalog *ii_atttype* with a column named *system_maintained*. As of Ingres II 2.5, *system_maintained* is a reserved word. Because of the keyword restriction, loading such a database into version 2.5 will fail. Release 2.6 and higher have a context sensitive keyword recognizer, and does not have the problem.

In Ingres II 2.5, the name of the `system_maintained` column is changed to *sys_maintained*. For the reload to work with 2.5, you must edit the original `copy.in` script to use the new column name. While you can also make this change using a utility such as `sed`, beware of inadvertently changing other uses of the *system_maintained* keyword.

Databases created with OpenIngres 1.x, Ingres version 6.4, and older do not usually contain the *ii_atttype* catalog. If you unload/reload a 6.4 database containing *ii_atttype*, you have to manually edit the file `cp_ingre.in` and fix *system_maintained* to *sys_maintained*.

Compile Applications

After you have successfully imported your databases into the Ingres development environment, you must compile your applications in that environment.

In most cases, you will want to make a copy of the application source code and libraries. Make sure that any compile scripts, linker command files, and the like point to the Ingres development installation, not the original development installation.

When you can successfully compile your applications with Ingres, you are ready to start testing.

Note: If you are upgrading from Ingres 6.4, check for the additional application issues under Considerations for Ingres 6.4 (see page 79).

How You Prepare Your System

Some upgrade tasks involve system or Ingres administration. Coordinate these changes with the system administrator.

The system administrator should back up the Ingres system and make sure the system can be restored from the backup.

In addition, changes may be required to the following:

- System monitoring shellscripts
- Your customized checkpoint template files
- Shared library search path
- UNIX kernel parameters

System Backup

When upgrading, it is important to have a system backup. If something goes wrong, you will be able to restore from the backup.

Make sure that the system administrator knows how to take a complete system backup and how to restore that backup. Do a trial backup and verify that the backup is readable. This is especially important with tapes: failing tape drives can appear to write tapes without error, but the tapes may not be readable.

The system administrator should ensure that proper backup procedures are being followed. Backups taken as part of an upgrade should be removed from any backup media recycling, and kept in a secure location for a long time.

System Monitoring Shellscripts

Production systems may have tools to provide the system administrator with early warning of Ingres problems. If these tools have been developed in-house, they must be reviewed for compatibility with your new Ingres release.

Check for these items:

- Are there still IO slaves on the UNIX platform? OS-thread architectures such as Windows and Sun Solaris do not use IO slaves.
- Does the tool parse iimonitor, logstat, or lockstat output? The detailed wording and positioning of logstat and lockstat output can change from release to release. Consider using IMA instead.
- If you are upgrading from Ingres 6.4, the log files II_RCP.LOG and II_ACP.LOG are renamed to iircp.log and iiacp.log.
- If your tool parses Ingres 6.4 parameters, you will have to change it. Ingres parameters are held in the files config.dat and protect.dat.
- If you are using a commercial monitoring tool, contact the vendor to see if an upgrade is needed to support Ingres.

If your Ingres monitoring tool uses the Ingres Monitoring Architecture (IMA), it is likely to continue to function with new Ingres versions. IMA is the recommended data source for any Ingres monitoring tool.

Checkpoint Template Changes

The Ingres checkpoint template file, `cktmpl.def`, may change from release to release. If you have customized your checkpoint template file, you must review and verify your changes with the new Ingres version.

If you are upgrading from Ingres 6.4, or from OpenIngres 1.2, you must redo your template changes. The `cktmpl.def` file format has been expanded since Ingres 6.4 and is therefore not compatible. The OpenIngres 1.2 template file format is similar to the current one, but additional entries are required. Your old checkpoint template can serve as a guide.

For more information on the format of the checkpoint template file, see the *Database Administrator Guide*.

Tip: If your checkpoint template was customized to do multiple location checkpoints in parallel, you may be able to remove this customization entirely. Ingres supports parallel checkpoint and `rollforwarddb` processing directly.

If you are upgrading from an Ingres II release, compare your revised checkpoint template against the one installed with your new Ingres version. You may be able to use your customized template as is, but first check for new or changed entries in the new version.

The Ingres development installation can be used to develop and test the new `cktmpl.def`.

Checkpoint and Rollforward Changes

Typically, checkpoints and journals are not compatible from one version to the next. After an installation is upgraded, you must assume that all old checkpoints and journal files are no longer usable with the new version of Ingres.

`Rollforwarddb` no longer supports a `-b` option. (In Ingres 6.4, the `-b` option gave a starting time for applying journals.) `Rollforwarddb` no longer supports the `-noblobs` option because it makes the table physically inconsistent and unusable.

Shared Library Search Path (UNIX)

On many UNIX platforms, Ingres uses shared libraries. Since there is no default installation directory for Ingres, it is necessary to tell applications and tools where Ingres is installed so that the shared libraries can be found.

Define Shared Library Search Path (UNIX)

To define the Ingres installation shared library search path, use *one* of the following methods:

- For all users who access any Ingres programs or applications, set the library environment variable (for example, `LIBPATH`, `LD_LIBRARY_PATH`, or `SHLIB_PATH`) to include the Ingres library directory, `$II_SYSTEM/ingres/lib`.

Failure to set the library variable will result in an error message:

```
ld.so.1:      /ing20/20/ingres/bin/tm: fatal:
libframe.1.so: open failed: No such file or directory
```

You can arrange for this setting ahead of time, while you are still running Ingres 6.4. The 6.4 binaries do not use `LD_LIBRARY_PATH`.

The exact name of the environment variable depends on your flavor of UNIX. Most UNIX environments use `LD_LIBRARY_PATH`; HP-UX uses `SHLIB_PATH`; AIX versions 3 and 4 use `LIBPATH`. See the `ld(1)` or `ld.so(1)` man page in your operating system documentation.

- Link the Ingres library files to a standard UNIX library directory, such as `/usr/lib`.

For example:

```
ln -s /ing20/ingres/lib/libframe.1.so /usr/lib
```

and repeat for each `.so` file in the Ingres `lib` subdirectory.

This approach does not require application wrappers or user environment changes. The disadvantage is that you have to link (or copy) each Ingres library individually, and check the validity of these links after a subsequent upgrade.

UNIX Kernel Parameters

Review the UNIX kernel parameter settings, particularly the maximum shared memory size.

If upgrading from Ingres 6.4, you may have to increase the size of a shared memory segment because Ingres builds a larger shared memory segment for locking and logging than did Ingres 6.4.

A 100 MB shared memory segment will accommodate most migrated installations. Each platform has its own way of modifying the shared memory limits; discuss this with the system administrator or read the platform-specific information in the Readme file.

If upgrading from a more recent version of Ingres, you probably do not have to change the kernel parameters. It is prudent to configure your new Ingres development installation similar to the production installation, to make sure that no kernel changes are needed.

Testing

In your new installation, you should test your applications, query performance, and system administrator procedures.

Application Testing

As changes are made to the application for Ingres compatibility, bring the changes over to the development Ingres installation and test your applications according to your test plan.

When testing, use data that is as close to live data as possible. Performance-critical functions should be tested against production data volumes.

Performance Testing

Include performance testing in your test plan. Changes to the query optimizer can cause queries to perform differently from your original Ingres version.

Typically, queries are faster, but in some cases, may be slower. This is likely when a query has been tuned to work well with a peculiarity of the old-version query optimizer. If you notice performance problems, use the `set qep` command or the QEP display of Visual DBA. For more information on the use of query plans and optimizer statistics, see the *Database Administrator Guide*.

System Administrator Procedure Testing

You should test your system administration procedures.

Test the Ingres installation when it is busy by pulling the power plug or issuing a system command to crash the servers. Make sure that recovery occurs correctly.

Do at least one rollforwarddb of the most important databases and make sure it works in your environment.

How You Practice the Upgrade

You should run a trial upgrade as early as possible in the conversion cycle. Ideally, you should run trial upgrades more than once, so an isolated environment is desirable.

Follow this process:

1. Run a trial upgrade.
2. Take notes on what went wrong or what should be done differently.
3. Continue running trial upgrades until no more problems are encountered.

Note: Perform at least one of the trial upgrades on a full live data set so that you have an indication of how long the upgrade will take. This is particularly important when doing an unload/reload upgrade. In contrast, upgradedb type upgrades are largely insensitive to the amount of data in the database.

4. Give the annotated upgrade procedure to someone who can verify the upgrade plan.

How You Prepare a Build for the Live Upgrade

You should use a new build for the live upgrade.

As the date for the live upgrade approaches, follow this process:

1. Freeze all changes.
2. Delete *all* application objects and images from the development Ingres installation.
3. Re-image everything.
4. Use this refreshed copy for, at least, a critical functions test.
5. Use this build for the live upgrade.

Chapter 3: Upgrading Using Upgradedb

This chapter describes how to use the upgradedb utility to upgrade from any version of Ingres.

Note: If you have difficulties upgrading from Ingres 6.4 with the upgradedb procedure in this chapter, you can use the Alternate Upgradedb Procedure in the appendix “Upgrading from Ingres 6.4.”

Ownership Assumptions for Running Upgradedb

The upgradedb procedure assumes that you can become any user who owns objects in any database (using login or UNIX “su”). If this is not feasible, you can run as the installation owner, and use the -u{user} flag to pretend to be that user any time you have to run an Ingres command.

How You Upgrade Using the Upgradedb Utility

Upgrading using upgradedb transforms your database in-place from the original version to the new, without requiring an unload and reload.

To upgrade using upgradedb, use the following process.

Note: In this process, the notation **[Each DB]** means: "For each database, not including the iidbdb (master database), become the DBA for that database and perform this step." Do not include the iidbdb or Ingres Star distributed databases unless instructed. If using Ingres Star, remember to include the coordinator database in the list of databases.

1. Disable user access.
2. Disable Remote Command Server.
3. Shut down Ingres and back up system.
4. [Each DB including the iidbdb] Clean the database.
5. [Each DB] Record database information.
6. [Each DB including the iidbdb] Checkpoint and turn off journaling.
7. Shut down Ingres.
8. Preserve site modifications.
9. (Optional) Delete install directory (UNIX).
10. Install Ingres.
11. Create imadb database.
12. Restore site modifications.
13. Start Ingres.
14. Run upgradedb utility.
15. Review Ingres configuration.
16. (Optional) [Each DB] Reapply optimizer statistics.
17. [Each DB including the iidbdb] Checkpoint the database.
18. Install upgraded applications.

For details on each step, see the following sections.

Disable User Access

During the upgrade, the production system is not available for use. Make sure that users are not able to access the databases until the upgrade is complete.

Disable Remote Command Server

The Remote Command Server component of Visual DBA must be disabled for the duration of the upgrade. The Remote Command Server uses the iidbdb database as a communications mechanism in versions of Ingres prior to 2.6, so it will interfere with upgrading.

Note: If you are upgrading from early versions of OpenIngres 1.x, and you do not see an entry in CBF for the Remote Command Server, skip this step.

To disable the Remote Command Server

1. Run Configuration-By-Forms.
2. Locate the row for the Remote Command Server.
3. Note the startup count and record this value for later.
4. Use the EditCount function to set the startup count to zero.

Shut Down Ingres and Back Up System

You should perform a clean shutdown of Ingres, clearing all transactions from the transaction log, and then back up your system.

To perform a clean shutdown of Ingres

1. Shut down Ingres.
2. Restart Ingres.
3. Shut down Ingres again.
4. Check the recovery process log (iircp.log) for the message "RCP Shutdown completed normally."

To back up your system

1. Use a command appropriate to the platform to perform the backup.
2. Back up all Ingres directories, including data, checkpoint, journal, dump areas, and the \$II_SYSTEM/ingres directory containing Ingres files and executables.
3. Back up the application directories

Note: Watch for symbolic links and cross-mounts; make sure real data is saved and not a symbolic link.

4. Include the root file system in the backup if Ingres is typically started up at boot time. Alternatively, print a copy of any Ingres boot time startup and shutdown scripts.
5. Perform the backup twice to ensure that you have an extra copy of your backup. This step ensures maximum safety.
6. Check the backup media to ensure that the backup can be read. If your backup medium is tape, use new tapes, and clean the tape drive before the backup.
7. Restart Ingres.

Clean the Database

To ensure the integrity of the system catalogs, issue the following commands:

```
sysmod dbname  
  
verifydb -mreport -sdbname dbname -odbms_catalog
```

The verifydb command may issue the following messages; you can ignore them.

S_DU1611_NO_PROTECTS iirelation indicates that there are protections for table (owner), but none are defined.

S_DU0305_CLEAR_PRTUPS Recommended action is to clear protection information from iirelation, and S_DU1619_NO_VIEW iirelation indicates that there is a view defined for table (owner), but none exists.

S_DU030C_CLEAR_VBASE Recommended action is to clear view base specification from iirelation.

You can also ignore the “patch warning” message that warns of the loss of user tables in “runinteractive” mode. This mode will not be used.

If verifydb issues warnings or errors other than those in Step 1, review the messages with Ingres Technical Support before upgrading that database, because there may be damage to the system catalog.

Record Database Information

For each database, you will need to know information such as whether the database was journaled, where the database resides, and in what order the data locations were configured.

To record database information

1. Run infodb against each database. Issue the following command:

```
infodb dbname >infodb.out
```

Save the output for later.

2. Record whether the database is public or private.

To find out, use the catalogdb command. Select Databases, and then enter the database name. The screen that appears has an Access field that indicates whether the database is public or private.

Checkpoint and Turn Off Journaling

For each database, including the iidbdb, checkpoint each database and turn off journaling. Then save the configuration file.

To checkpoint and turn off journaling

1. Checkpoint each database, using the ckpdb command with `-j` option to turn off journaling. (The upgradedb process turns off journaling, so it is best to do that now.) If upgradedb fails, you can use this checkpoint to recover and try again.

Issue the following command:

```
ckpdb -d -j dbname
```

2. Save the configuration file stored in the dump area after each checkpoint. The configuration file is small. Issue the following command:

```
cp $II_DUMP/ingres/dmp/default/dbname/aaaaaaaa.cnf {somewhere secure}
```

Shut Down Ingres

Shut down Ingres with the ingstop command.

Preserve Site Modifications

Files distributed as part of Ingres that you have customized will be lost during the upgrade. Any custom files you have *added* to the \$II_SYSTEM directory tree will remain.

You must copy your customized files to a safe place. Do *not* copy them to /tmp or anywhere in \$II_SYSTEM/ingres directory.

If local collation sequence files have been customized, save the original collation definition files and the compiled files that reside in \$II_SYSTEM/ingres/files/collation.

Commonly Customized Files

The following files are typically customized:

- Termcap files in \$II_SYSTEM/ingres/files
- Keyboard map files in \$II_SYSTEM/ingres/files
- Local collation sequence files

Preserve Necessary Files

If you cannot identify all your customized files, you can ensure that you preserve the necessary files by performing the following procedure. This procedure copies more files than necessary, but you can delete the copy after Ingres has been running live for a period.

To preserve necessary files

1. Delete all *.log files from \$II_SYSTEM/ingres/files
2. Copy to a safe place the entire contents of the following directories:
 - all .opt files
 - \$II_SYSTEM/ingres/bin
 - \$II_SYSTEM/ingres/files
 - \$II_SYSTEM/ingres/rep
 - \$II_SYSTEM_ingres/files/rep
 - \$II_SYSTEM/ingres/files/dayfile
 - \$II_ingres/files/startup
 - \$II_SYSEM/ingres/files/startsql
 - \$II_SYSTEM/ingres/utility

Note: Do not delete the copy immediately when the upgrade completes, because you may discover weeks later that you need the old version of a file (for example, a Vision template or keyboard map) from the original \$II_SYSTEM/ingres directory.

UNIX: On UNIX, to copy these files, use commands similar to the following:

```
cd $II_SYSTEM/ingres
```

```
tar cf - bin files rep utility | (cd /someplace/safe;tar xf -) 
```

Visual DBA Configurations

When upgrading, Visual DBA configuration files (.vdbacfg) are not upwardly compatible and must be recreated.

Note: Instead of using configuration files, you can use the vdba command with command line flags to start Visual DBA with, for example, certain windows open on given nodes. For details on the vdba command, see the *Command Reference Guide*.

(Optional) Delete Install Directory (UNIX)

Note: This step is optional but recommended.

The Ingres installation procedure on UNIX starts by extracting the install subdirectory from the Ingres distribution.

You should delete the old contents of that directory first, as follows:

```
cd $II_SYSTEM/ingres  
  
rm -rf install
```

Install Ingres

To install Ingres, see the Ingres installation instructions for your platform.

During the installation process, the DBMS Server setup asks whether all databases are to be upgraded; answer **No**. The installation procedure automatically upgrades the iidbdb. If the upgrade of iidbdb fails, see the chapter "Troubleshooting Upgradedb." It is better to complete the Ingres setup, and then use the upgradedb command to upgrade the user databases.

If you are upgrading from 6.4, and the 6.4 installation has Ingres Star databases, you *must* respond **No** to this prompt. At this point in the 6.4 upgrade, the Star Server is not yet set up.


After the iidbdb is upgraded, the DBMS Server setup attempts to upgrade imadb and install Remote Command Server objects into imadb. Some versions of upgradedb neglect to create imadb first, and you will get "Database does not exist: imadb" errors. These will be corrected in the next step.

How You Upgrade to Older Versions That Require a Patch

Newer versions of Ingres distribute service packs. You can install service packs without having to install a base release of Ingres first.

UNIX: If you are upgrading to an older Ingres version that requires an overlay patch instead of a service pack, follow this procedure:

1. Run ingbuild. When asked whether you want to set up all the Ingres components, respond **No**. Exit ingbuild.
2. Install the Ingres patch.
3. Run ingbuild again. Select Current, then SetupAll.
4. Follow the prompts to complete the Ingres setup.

Setup now uses the fixed version. 

Create imadb Database

Note: Perform this step only if you received “Database does not exist: imadb” messages during the DBMS setup phase of your Ingres install. This should only occur if you are upgrading from OpenIngres 1.x to Ingres 2.6 or older.

To create the imadb database, as the installation owner, execute these commands:

UNIX:

```
ingstart
cd $II_SYSTEM/ingres/vdba
createdb '-u$ingres' imadb -f nofeclients
sql '-u$ingres' imadb <makimau.sql
rmcmdgen
ingstop
```

Windows:

```
ingstart
cd %II_SYSTEM%\ingres\vdba
createdb -u$ingres imadb -f nofeclients
sql -u$ingres imadb <makiman.sql
rmcmdgen
ingstop
```

As the makimau or makiman SQL scripts run, you see a series of messages such as “E_US0AC1 '*some-name*' does not exist or is not owned by you.” These are normal and can be ignored.

Restore Site Modifications

Refer to the save directory that was created in the step Preserve Site Modifications, and review any site-specific files that were overwritten by the upgrade.

Carry Forward Checkpoint Template Modifications

If the checkpoint template file cktml.def has been modified, the modifications may need to be carried forward into Ingres. Your original cktml.def should not be used directly, because entries can be added or revised in new versions of Ingres. Compare your customized cktml.def with the newly installed file, and make necessary changes in the new cktml.def. For information about the checkpoint template, see the *Database Administrator Guide*.

Start Ingres

Run ingstart to start Ingres.

Run Upgradedb Utility

Run the upgradedb utility to upgrade databases. You can upgrade databases one at a time or all at the same time. Log the upgradedb output to a file.

To upgrade one at a time:

```
upgradedb dbname
```

To upgrade all at the same time:

```
upgradedb -all
```

Example of logging upgradedb output to a file:

```
upgradedb -all |& tee upgradedb.log
```

If errors occur, see the chapter “Troubleshooting Upgradedb.” Correct the errors and rerun the upgradedb utility.

Review Ingres Configuration

The upgrade preserves your original Ingres installation parameters. You should review the configuration because some parameters may change from version to version. For information on parameters that changed, check the Readme for your new version of Ingres.

Review your parameter settings by running Configuration-By-Forms or Visual Configurator. Especially pay attention to major items such as startup counts and DBMS cache settings.

Note: If you disabled the Remote Command Server in an earlier step of the upgradedb process, use EditCount to restore its startup count to the original value.

(Optional) Reapply Optimizer Statistics

Note: This step is required only if upgrading from OpenIngres 1.x or Ingres 6.4. Ingres computes additional metrics that those releases did not have.

To take advantage of the new metrics, regenerate the optimizer statistics using the procedures of your application system.

Checkpoint the Database

Checkpoints and journals from your original Ingres version will not work with the newer version, so do not omit or delay this step.

Checkpoint each database, including the iidbdb. If the database was journaled previously, use the +j flag to turn on journaling.

To know which databases were journaled, see the infodb output from the step Record Database Information.

The iidbdb should always be journaled, regardless of whether it was journaled in the original installation.

Install Upgraded Applications

To perform the last step of the upgrade procedure:

1. Install the Ingres versions of the applications.
2. Restore user logins
3. Resume normal operation.

Chapter 4: Upgrading Using Unload/Reload

This chapter describes how to use the unload/reload procedure to upgrade from a post-6.4 version of Ingres.

The unload/reload upgrade avoids the upgradedb program (except for iidbdb), in favor of unloading the original Ingres databases to flat files, recreating the databases under Ingres, and then reloading the databases. This approach has the advantage of starting with clean databases, but requires more time and disk space than does the upgradedb method.

Note: Databases using the system-maintained logical key feature are best upgraded using upgradedb. Tables that contain SYSTEM_MAINTAINED table_key or object_key columns cannot be safely unloaded and reloaded without additional work. The reload step generates all new logical key values. If other tables reference the logical key columns, the new values must be manually propagated to those tables.

Variations of Unload/Reload Procedure

The unload/reload procedure has two variations:

- The **in-place upgrade**, which replaces the original installation with the new Ingres installation. The master database (iidbdb) is upgraded with upgradedb, even though other databases are unloaded and reloaded. Because the iidbdb remains, all your locations, users, groups, and roles still exist in the new installation.
- The **clean install upgrade**, which leaves the original installation alone. Ingres is installed into a completely new installation. (The new installation may even be on a different machine.) When performing a clean install upgrade, you must take extra steps to recreate locations and move users, groups, and roles from the original installation to the new one.

How You Perform an Upgrade Using Unload/Reload

A database unload/reload ensures a clean start with a fresh database.

To perform an upgrade using unload/reload, use the following process.

Note: In this process, the notation **[Each DB]** means: "For each database, not including the iidbdb (master database), become the DBA for that database, **cd** to the unload directory for the database created in Step 1, and perform this step." If using Ingres Star, include the coordinator database in the list of databases. Steps that apply to a particular upgrade type only (that is, in-place upgrade or clean install upgrade) are marked accordingly.

1. [Each DB including iidbdb] Create unload directory.
2. [Each DB] Run unloaddb.
3. [Each DB] Check for obsolete users.
4. (Optional) [Each DB Including iidbdb] Checkpoint the database.
5. Disable user access.
6. Disable Remote Command Server.
7. Shut down Ingres and back up system.
8. [Each DB] Unload the database.
9. (Optional) [Each DB] Print optimizer statistics.
10. [Each DB] Record database information.
11. Record database privileges.
12. Save users, groups, and roles.
13. [Each DB] Destroy the database.
14. Clean iidbdb database.
15. Shut down ingres.
16. Disable Ingres startup.
17. Preserve site modifications.
18. (Optional) Delete install directory (UNIX).
19. Install Ingres.
20. Create imadb database.
21. Restore site modifications.
22. Review Ingres configuration.
23. Set up Ingres Net.
24. Start Ingres.

25. Recreate users, groups, and roles.
26. Recreate locations.
27. [Each DB] Recreate the database.
28. [Each DB] Extend the database.
29. Recreate database privileges.
30. [Each DB] Fix FE reload script.
31. [Each DB] Reload the database.
32. [Each DB] Upgrade front-end catalogs.
33. [Each DB] Reapply optimizer statistics.
34. [Each DB] Checkpoint the database.
35. Install upgraded applications.

For details on these steps, see the following sections.

Create Unload Directory

You should create a directory to hold scripts and data from the unloaded database.

Note: This directory requires a large amount of disk space. As an estimate, the unloaded data is about the same size as the Ingres database; however, compressed data can expand to take up much more space than the Ingres database.

To create a directory, issue the following commands for each database:

UNIX:

```
mkdir /someplace/dbname
```

```
chmod 777 /someplace/dbname
```

Windows:

```
mkdir d:\someplace\dbname
```

Run Unloaddb

Run unloaddb against each database. The unloaddb command does not unload the database; it simply creates scripts.

For Ingres Star databases, unload the CDB in the same way as for a local database. For a DDB, use unloaddb/star.

For a regular DB or CDB, issue this command:

```
unloaddb dbname
```

For an Ingres Star DDB, issue this command:

```
unloaddb dbname/star
```

If doing a clean-install upgrade to a different machine that has a newer architecture, binary data may not be compatible between the two machines. If this is the case, use the unloaddb **-c** option, which causes an ASCII instead of binary unload.

Check for Obsolete Users

Old databases may have objects created by users who no longer exist. Check for obsolete users for each database.

To check for obsolete users:

1. Examine the scripts created by unloaddb in the step Run Unloaddb of the upgrade procedure.
Each script contains **set session authorization** SQL statements for each user who owns a database object.
2. Search for the **set session authorization** statements, and make sure that all users listed are valid.
3. Delete all the lines from the unwanted **set session authorization** statement up to the next one, if obsolete users are found.
4. Go into the database and clean out these unwanted objects.

(Optional) Checkpoint the Database

Note: This step is optional. You can omit this step if you can rely on the system backup to be taken in the later step Shut Down Ingres and Back Up System.

Follow these steps:

1. Checkpoint each database, including the iibdadb
2. Copy the checkpoint files to a permanent medium such as tape. Use fresh tape.
3. Verify that the tape can be read.

Disable User Access

During the upgrade, the production system is not available for use. Make sure that users are not able to access the databases until the upgrade is complete.

Disable Remote Command Server

The Remote Command Server component of Visual DBA must be disabled for the duration of the upgrade. The Remote Command Server uses the iibdadb database as a communications mechanism in versions of Ingres prior to 2.6, so it will interfere with upgrading.

Note: If you are upgrading from early versions of OpenIngres 1.x, and you do not see an entry in CBF for the Remote Command Server, skip this step.

To disable the Remote Command Server

1. Run Configuration-By-Forms.
2. Locate the row for the Remote Command Server.
3. Note the startup count and record this value for later.
4. Use the EditCount function to set the startup count to zero.

Shut Down Ingres and Back Up System

You should perform a clean shutdown of Ingres, clearing all transactions from the transaction log, and then back up your system.

To perform a clean shutdown of Ingres

1. Shut down Ingres.
2. Restart Ingres.
3. Shut down Ingres again.
4. Check the recovery process log (iircp.log) for the message "RCP Shutdown completed normally."

To back up your system

1. Use a command appropriate to the platform to perform the backup.
2. Back up all Ingres directories, including data, checkpoint, journal, dump areas, and the \$II_SYSTEM/ingres directory containing Ingres files and executables.
3. Back up the application directories

Note: Watch for symbolic links and cross-mounts; make sure real data is saved and not a symbolic link.

4. Include the root file system in the backup if Ingres is typically started up at boot time. Alternatively, print a copy of any Ingres boot time startup and shutdown scripts.
5. Perform the backup twice to ensure that you have an extra copy of your backup. This step ensures maximum safety.
6. Check the backup media to ensure that the backup can be read. If your backup medium is tape, use new tapes, and clean the tape drive before the backup.
7. Restart Ingres.

Unload the Database

For each database, run the unload.ing script created by the unloaddb command. The database is unloaded into your unload directory.

(Optional) Print Optimizer Statistics

Note: This step applies only to a clean-install upgrade.

Print optimizer statistics for each database. If your upgrade plan allows enough downtime to run a full `optimizedb` against your databases, you can omit this step. If your plan does not allow enough downtime, perform this step as a shortcut.

Note: Using this shortcut may result in some of the new Ingres metrics not being available; query performance may suffer until a full `optimizedb` can be completed.

If you are upgrading from OpenIngres 1.x, you should regenerate new statistics instead of saving the old ones, if possible.

To print the existing optimizer statistics, run `statdump` with the `-o` flag to a file for each database, as follows:

```
statdump -o dbname.stats dbname
```

Record Database Information

For each database, you will need to know information such as whether the database was journaled, where the database resides, and in what order the data locations were configured.

To record database information

1. Run `infodb` against each database. Issue the following command:

```
infodb dbname >infodb.out
```

Save the output for later.

2. Record whether the database is public or private.

To find out, use the `catalogdb` command. Select Databases, and then enter the database name. The screen that appears has an Access field that indicates whether the database is public or private.

Record Database Privileges

To record database privileges

1. As the installation owner, change directories to the unload directory for iiddb created in Step 1 of the upgrade procedure.
2. Run the following SQL to save user database privileges:

```
sql iiddb
\script dbprivs.out
select *
from iiddbprivileges
where database_name <> ''
order by database_name,grantee_name
\go
\script
\quit
```

The file dbprivs.out is created for future reference.

Save Users, Groups, and Roles

Note: This step is required only for a clean-install upgrade.

To save users, groups, and roles

1. As the installation owner, change directory to the iidbdb unload directory created in Step 1 of the upgrade procedure.
2. Run the following SQL to save users, groups, and roles:

```
sql iidbdb
copy iiusergroup (
  groupid=c0comma,groupmem=c0nl
) into 'groups.out'
\go

copy iirole(
  roleid=c0nl
) into 'roles.out'
\go

create table role_tmp as
select role_name,grantee_name
from iirolegrant
where admin_option <> 'Y'
\go
copy role_tmp(
  role_name = c0comma,
  grantee_name = c0nl
) into 'rolegrants.out';
drop role_tmp;
\go
\quit
```

3. Run accessdb, and select Users, then SqlScript.

A file called users.sql is written that will recreate all users, as they are currently defined.

Destroy the Database

Note: This step is required only for an in-place upgrade.

Destroy each database using the destroydb command.

Clean iidbdb Database

Note: This step is required only for an in-place upgrade.

To clean the iidbdb database

As the installation owner, run the following steps against the master database iidbdb:

Note: It is assumed that there are no objects created by users in the iidbdb.

```
sysmod iidbdb  
  
verifydb -mrun -sdbname iidbdb -opurge  
  
verifydb -mrun -sdbname iidbdb -odbms  
  
ckpdb -j iidbdb
```

The verifydb command may issue the following messages, which you can ignore:

S_DU1611_NO_PROTECTS iirelation indicates that there are protections for table (owner), but none are defined.

S_DU0305_CLEAR_PRTUPS Recommended action is to clear protection information from iirelation, and S_DU1619_NO_VIEW iirelation indicates that there is a view defined for table (owner), but none exists.

S_DU030C_CLEAR_VBASE Recommended action is to clear view base specification from iirelation.

You can also ignore the “patch warning” message that warns of the loss of user tables in “runinteractive” mode. This mode will not be used.

Disable Ingres Startup

If Ingres starts automatically when the machine boots up, turn auto-starting off until the upgrade is complete.

To disable Ingres startup and put operating system changes into effect

1. Follow the procedures for your platform:

UNIX: On most UNIX platforms, a file in a system startup directory performs Ingres startup and shutdown; place an "exit 0" at the top of this file. The system administrator may need to perform this step if it requires root privilege. (The system startup directory depends on your platform—/etc/init.d, or /sbin/init.d, or a similar name).

Windows: If Ingres is run as a system service, set the service to start manually instead of automatically.

2. Make sure that the operating system is correctly configured for your new version of Ingres, as described in How You Prepare Your System (see page 30).
3. Reboot, if necessary, to put the operating system parameter changes into effect.

Note: This step is recommended even if you are doing a clean installation upgrade. By leaving the old installation shut down, you eliminate the chance that someone will connect to it by mistake later.

Preserve Site Modifications

Files distributed as part of Ingres that you have customized will be lost during the upgrade. Any custom files you have *added* to the \$II_SYSTEM directory tree will remain.

You must copy your customized files to a safe place. Do *not* copy them to /tmp or anywhere in \$II_SYSTEM/ingres directory.

If local collation sequence files have been customized, save the original collation definition files and the compiled files that reside in \$II_SYSTEM/ingres/files/collation.

Visual DBA Configurations

When upgrading, Visual DBA configuration files (.vdbacfg) are not upwardly compatible and must be recreated.

Note: Instead of using configuration files, you can use the vdba command with command line flags to start Visual DBA with, for example, certain windows open on given nodes. For details on the vdba command, see the *Command Reference Guide*.

(Optional) Delete Install Directory (UNIX)

Note: This step is optional but recommended.

The Ingres installation procedure on UNIX starts by extracting the install subdirectory from the Ingres distribution.

You should delete the old contents of that directory first, as follows:

```
cd $II_SYSTEM/ingres
rm -rf install
```

Note: This step is required only for an in-place upgrade on UNIX.

Install Ingres

To install Ingres, see the Ingres installation instructions for your platform.

In-place upgrades only: During the installation process, the DBMS Server setup asks whether all databases are to be upgraded; answer **No**. The install procedure automatically upgrades the iidbdb. If the upgrade of iidbdb fails, see the appendix “Troubleshooting Upgradedb.”


After the iidbdb is upgraded, the DBMS Server setup attempts to upgrade imadb and install Remote Command Server objects into imadb. Some versions of upgradedb neglect to create imadb first, and you will get “Database does not exist: imadb” errors. These will be corrected in the next step.

How You Upgrade to Older Versions That Require a Patch

Newer versions of Ingres distribute service packs. You can install service packs without having to install a base release of Ingres first.

UNIX: If you are upgrading to an older Ingres version that requires an overlay patch instead of a service pack, follow this procedure:

1. Run `ingbuild`. When asked whether you want to set up all the Ingres components, respond **No**. Exit `ingbuild`.
2. Install the Ingres patch.
3. Run `ingbuild` again. Select Current, then SetupAll.
4. Follow the prompts to complete the Ingres setup.


Setup now uses the fixed version. 

Create imadb Database


Note: Perform this step only if you received "Database does not exist: imadb" messages during the DBMS setup phase of your Ingres install. This should only occur if you are upgrading from OpenIngres 1.x to Ingres 2.6 or older.

To create the imadb database, as the installation owner, execute these commands:

UNIX:

```
ingstart
cd $II_SYSTEM/ingres/vdba
createdb '-u$ingres' imadb -f nofeclients
sql '-u$ingres' imadb <makimau.sql
rmcmdgen
ingstop 
```

Windows:

```
ingstart
cd %II_SYSTEM%\ingres\vdba
createdb -u$ingres imadb -f nofeclients
sql -u$ingres imadb <makiman.sql
rmcmdgen
ingstop 
```

As the makimau or makiman SQL scripts run, you see a series of messages such as "E_US0AC1 '*some-name*' does not exist or is not owned by you." These are normal and can be ignored.

Restore Site Modifications

Restore any site-specific files that you copied in the step Preserve Site Modifications.

If the checkpoint template file cktmpl.def has been modified, the modifications may need to be carried forward into Ingres. The cktmpl.def from Ingres 6.4 cannot be used with Ingres, as the file format has changed. This means that you must recreate the changes using the Ingres 6.4 cktmpl.def as a guide. See the Ingres 6.4 *Database Administrator's Guide*.

If the archiver exit script acpexit was changed in Ingres 6.4, you must make the changes to the Ingres template (acpexit.def), and then move that file to \$II_SYSTEM/ingres/files/acpexit.

Review Ingres Configuration

If you are doing a clean install, you need to change the default Ingres configuration to match your site requirements.

If you are doing an in-place upgrade, the upgrade process preserves your original Ingres installation parameters. You should review the configuration because some parameters may change from version to version. For information on parameters that changed, check the Readme for your new version of Ingres.

Review your parameter settings by running Configuration-By-Forms or Configuration Manager. Especially pay attention to major items such as startup counts and DBMS cache settings. If you are doing a clean install, you can use your original Ingres installation configuration as a guide.

Note: If you disabled the Remote Command Server in the step Disable Remote Command Server, use EditCount to restore its startup count to the original value.

Set Up Ingres Net

Create the vnode definitions for the remote installations by using netutil. If using shadow passwords on UNIX, you must run mkvalidpw. For details, see the *Connectivity Guide*.

If there are NFS client-only installations that have not been set up, run ingmknfs to set them up.

Start Ingres

Run `ingstart` to start Ingres.

Recreate Users, Groups, and Roles

Note: This step is required only for a clean-installation upgrade.

To recreate users, groups, and roles:

1. As the installation owner, change directory to your `iidbdb` `unloaddb` directory where you stored the files from the step Save Users, Groups, and Roles of this upgrade procedure
2. Run this SQL to recreate users and groups:

```
sql '-u$ingres' iidbdb
copy iiusergroup(groupid=c0comma,groupmem=c0nl)
from 'groups.out'
\go
commit
\go
\read users.sql
commit
\go
\quit
```

Windows: Omit the quotes from the `sql` command line. 

The file `users.sql` may try to recreate some users that already exist in the installation, such as the installation owner and root user. This will cause “E_US18B6 The user '*name*' already exists” errors. You can ignore these errors.

3. If your original installation had roles defined, recreate them with the `ADD ROLE` SQL statement. Use the file `roles.out` as a guide.

Roles cannot be reliably bulk-loaded from the original installation, so you must recreate them by hand. After you recreate each role, issue the following SQL statement:

```
grant rolename to user; commit
```

The most common *user* here is **public**. You can use the file `rolegrants.out` to determine what role grants are needed.

Recreate Locations

Note: This step is required only for a clean-install upgrade.

To recreate locations:

1. Refer to **each** infodb output saved in the step Record Database Information of this upgrade procedure.
2. Create any location that is not a default installation location (ii_database, ii_checkpoint, ii_journal, or ii_dump). For more information about creating locations, see the *Database Administrator Guide*.

Recreate the Database

Before creating each database, refer to the infodb output saved in the step Record Database Information of this upgrade procedure. Look at the location names for ROOT, JOURNAL, CHECKPOINT, and DUMP. If these are not ii_database, ii_journal, ii_checkpoint, or ii_dump, you must specify the location to createdb with the -d, -j, -c, or -b flags, respectively.

Also, refer to the database access information recorded in that step. If the database access was "private," you must use the -p flag for createdb.

If all the database locations are the default, and the database is public, you can omit the flags on the createdb command line.

Recreate each user database, omitting the front-end catalogs. (The front-end catalogs will be created as part of the reload.) Use the following command:

```
createdb dbname flags -f nofeclients
```

Note: For an Ingres Star database, run createdb/star for the DDB. Do not run createdb for the CDB.

Extend the Database

To extend each database:

1. Refer to the infodb output saved in the step Record Database Information of this upgrade procedure.
2. If the database was extended to data locations other than the default location, run accessdb as the installation owner and extend the newly-created databases to the same locations. The locations will already exist; it is only necessary to extend the databases to use them.

If you prefer a non-interactive command line utility, you can use the extenddb utility instead of accessdb.

Recreate Database Privileges

To recreate database privileges:

1. As the installation owner, change to the iidbdb unloaddb directory.
2. Refer to the file dbprivs.out created in the step Record Database Privileges.

Each row in the dbprivs.out file describes one or more database privileges given to the user *grantee-name*. A Y or N in a privilege column indicates the specific privilege. (A U in a column means "Unchanged.")

3. Start an iidbdb Terminal Monitor session:

```
sql iidbdb
```

4. For each row, issue the statement:

```
grant privilege on database database-name to grantee-name;commit
```

If the privilege column is N, grant *noprivilege* instead of *privilege*.

5. When finished, use **\quit** to exit the iidbdb session.

The structure of the iidbpriv catalog did not change between OpenIngres 1.x and Ingres 2.6, so it is possible to copy the original contents of the catalog directly. However, we do not recommend this because the catalog may change in future releases.

If you have defined many privileges, or recreated many users, groups, or roles, you should run sysmod on the iidbdb, which will accelerate query processing. Issue the sysmod command, as follows:

```
sysmod iidbdb
```

Fix FE Reload Script

Because the new database was not created with front-end catalogs, it is not necessary to drop them.

To fix the front-end reload script, for each database:

1. Open the file copy.in.
2. Delete the following lines:

```
\include/ing12/ingres/files/iiud.scr  
\include/ing12/ingres/files/iiud65.scr
```

Note: The directory path may differ.

3. Check for the *ii_atttype* catalog definition:

```
create table ii_atttype (  
.  
.  
...about 23 lines...  
.  
.  
system_maintained char(1) not null
```

4. Change the name system_maintained to sys_maintained.

Not all databases contain the *ii_atttype* catalog, so it is okay if you do not find the definition.

5. Save the modified copy.in file.

Reload the Database

To reload the database:

1. Run reload.ing for each database.

UNIX: Redirect the reload to a log file so that it can be checked for errors. Using the C shell:

```
reload.ing |& tee reload.log
```

Note: If using Ingres Star, reload the CDB and all “real” local databases before reloading the DDBs. 🚧

2. After the reload is complete, verify that the table *ii_id* has only one row.

Type **isql** <database>, and **select * from ii_id**.

3. If more than one row is returned, delete the row with the lowest object_id.

Upgrade Front-End Catalogs

To upgrade the front-end catalogs to the new Ingres level, run `upgradefe` on each database.

Issue the following command:

```
upgradefe dbname INGRES
```

Type the word INGRES in uppercase.

Reapply Optimizer Statistics

Reapply optimization statistics for each database. You can do this by either:

- Regenerating statistics from scratch.

If there is sufficient time, we recommend that you regenerate the optimizer statistics using the procedures of your application system.

- Using the statistics printed from the original installation in the step Print Optimizer Statistics earlier in this upgrade procedure.

If time is short, and if you printed the original statistics, you can read them back in with the `-i` option to `optimizedb`:

```
optimizedb dbname -i dbname.stats
```

Checkpoint the Database

Checkpoints and journals from your original Ingres version will not work with the newer version, so do not omit or delay this step.

Checkpoint each database, including the `iidbdb`. If the database was journaled previously, use the `+j` flag to turn on journaling.

To know which databases were journaled, see the `infodb` output from the step Record Database Information.

The `iidbdb` should always be journaled, regardless of whether it was journaled in the original installation.

Install Upgraded Applications

To perform the last step of the upgrade procedure:

1. Install the Ingres versions of the applications.
2. Restore user logins
3. Resume normal operation.

Chapter 5: Troubleshooting Upgradedb

This chapter describes how to troubleshoot problems you may encounter when using the upgradedb utility.

The best way to avoid problems with the upgradedb utility is to upgrade to the most recent service pack of Ingres, and to follow the upgrade steps carefully.

Note: If you are upgrading to Ingres II versions 2.0 or 2.5, make sure you install the latest patch available for your platform before performing the upgradedb step.

The upgradedb utility starts to process, and then hangs with no error indication.

This condition is probably caused by the Remote Command Server interfering with the upgradedb process, which is likely if you are upgrading to Ingres II 2.0 instead of Ingres 2006. Use the `rmcmdstp` command to stop the Remote Command Server.

You can use Configuration-By-Forms or Visual Configurator to turn off the Remote Command Server until the upgrade is finished: select Remote Command Server and use EditCount to set the startup count to zero.

The following message occurs: "Product *name* has been made uninstallable by an incompatible dictionary upgrade."

This message is caused by extra or incorrect rows in the front-end catalog `ii_client_dep_mod`. The rows may have been created by very old versions of Ingres. You can ignore this message.

The following message occurs shortly after the upgradedb utility starts processing a database: "E_SC0206 An internal error prevents further processing of this query."

This message is seen when **upgradedb -all** is used, and the database data ROOT location is not the same as others processed in the same upgradedb run. The `errlog.log` shows the message "E_DM9004_BAD_FILE_OPEN" referencing a filename: `aaaaaaaa.cnf`, shortly before the E_SC0206 message.

This message has occasionally been seen in various versions of upgradedb. Simply rerun upgradedb for the one failed database, and continue the upgrade.

Difficulties arise after upgradedb announces “Reloading query tree objects.”

The database may be usable but lack one or more views, permits, or other objects. Refer to the generated SQL script and output files in the directory `$II_SYSTEM/ingres/files/UPGRADEUSER/` (where UPGRADEUSER is the user who is running upgradedb, typically “ingres”). You may be able to resolve the problem by inspecting the output files. You can complete the upgrade by re-running the input script files through the Terminal Monitor. For assistance, contact Ingres Technical Support.

Other Upgradedb Problems

If something else goes wrong with the upgradedb utility, contact Ingres Technical Support for help.

For problems with a single database, customer support can assist you in restoring the database data files from your system backup and resetting the database information in iidbdb so that you can retry upgradedb. In the worst case, it may be necessary to restore the entire installation from your system backup, fix the database problem, and redo the upgrade.

Chapter 6: Considerations for Alpha OpenVMS

This chapter describes the steps required for upgrading Ingres on the Alpha OpenVMS platform from Ingres II 2.0 to Ingres 2.6/0401 or Ingres 2006 (axm.vms/100).

Use this chapter together with the appropriate edition of the Ingres *Installation Guide* or *Getting Started* guide and the Readme file.

OpenVMS Requirements

For the minimum process requirements for an Ingres system administrator, see the appendix "System Requirements for OpenVMS" in the *Installation Guide*. Also see the Readme file.

Considerations When Installing Ingres on OpenVMS

For full instructions on installing Ingres on OpenVMS, see the *Installation Guide*. The installation process has not changed significantly from Ingres II 2.0.

Ingres uses the VMSINSTAL procedure to install and configure its software. Using VMS, it is possible to create the new Ingres system administrator account, extract the software required, and configure Ingres. However, depending on how the installation progresses, some issues may develop.

You can install Ingres either directly from the CD-ROM or from a working area on the target system. If the files are transferred to the target node through FTP, they must be moved across in binary mode.

Mount the CD

If the machine has a CD-ROM drive, you can use the following command to mount the CD:

```
$ MOUNT /OVERRIDE=IDENTIFICATION /MEDIA_FORMAT=CDROM -  
/UNDEFINED_FAT=(FIXED:CR:32256) <CD Device>
```

To access the readme use the following:

```
$ MOUNT /OVERRIDE=IDENTIFICATION /MEDIA_FORMAT=CDROM -  
/UNDEFINED_FAT=STREAM:32767 CD_Device
```

Run VMSINSTAL

To run the installer, issue the following command from any privileged account that is defined as holding the privileges needed to run Ingres:

```
@sys$update:vmsinstal * distribution_medium
```

By default, the SYS\$ROOT area is used by VMSINSTAL to unpack the savesets in preparation for installing Ingres. If there is insufficient space available, then VMSINSTAL will fail. To specify an alternate working directory, you can use the awd parameter, as follows:

```
@sys$update:vmsinstal * <distribution_medium> options awd=device:[dir]
```

To log the installation process specify the option L when calling VMSINSTAL:

```
@sys$update:vmsinstal * <distribution_medium> options L
```


Known Installation Issues

Note: For more information about these issues, check the technical documents available at the Ingres Technical Support web site.

Creating the Ingres System Administrator account from within VMSINSTAL does not assign the correct process quotas to the account. (For the correct quotas, see the *Installation Guide*.) The workaround is to create the account before the VMSINSTAL process is started with the correct privileges and process quotas.

II_WORK is not picked up, if pre-defined in the local symbol table, when an Express installation is performed. The user must enter the correct information when prompted.

If Ingres is installed from a non-Ingres System Administrator account, imadb is created as the process owner for VMSINSTAL rather than the installation owner configured earlier. When Ingres is started, the RMCMD process will hang because it is running as a user that is unable to connect to the RMCMD catalogs in imadb. The workaround is to install Ingres as the intended Ingres System Administrator.

Schema Checking

Ingres reserves a number of new keywords, mostly for support of SQL additions. If names such as *substring*, *first*, or *cache* are used as column names, you must change the database schema. For a list of Ingres reserved words, see the appendix "Keywords" and the *SQL Reference Guide*.

If you are concerned that some column names in your database may conflict with reserved words, you can take a copy of the schema from the current installation and load it into an Ingres database. You should extend these checks to the applications to verify that tables and views created at runtime are not affected by the new keywords. Conflicts found in the schema and applications must be removed before moving to Ingres.

Application Rebuilding

In addition to migrating data, you must rebuild all applications that connect locally to an existing Ingres installation.

The following compilers have been tested and are known to work with Ingres for OpenVMS.

HP Ada

HP BASIC

HP C

HP COBOL

HP C++

HP Pascal

HP Fortran

Note: For the latest information, see the Readme.

Building Member_Aligned Against Ingres 2.6 or 2006

Note: This section applies only to migrating from releases prior to Ingres II 2.0/0011 (axm.vms/00).

With the move to a member_aligned version of Ingres, some applications must be rebuilt. You must rebuild applications that connect directly to an installation located on the same node, or through Ingres Net on the client node.

Building Vision and Application-By-Forms applications member_aligned is the default behavior, with no further changes being required from the developer.

C	/MEMBER_ALIGNED
Pascal	/ALIGN=ALPHA_AXP
COBOL	/ALIGNMENT=PADDING
Fortran	/ALIGNMENT=ALL

If an application cannot be built using Alpha member alignment, it is possible to rebuild it with the Ingres components naturally aligned. The steps needed for C and COBOL applications are described in the following sections.

These changes require modification to the Ingres supplied files only and not the application code. Even by performing the steps listed here, you still must recompile **all** parts of the application that interface with Ingres or that use any structures declared in the Ingres header files.

By default, user applications are built using the same compiler options used to build the Ingres libraries and applications. If these options are not used, proceed carefully.

The introduction of the member_aligned version of Ingres occurred when alignment-related memory issues were encountered in Ingres II 2.0/9808 (axp.vms/00). If any applications are built using un-aligned structures with the communicating interface to Ingres, data corruption is likely to occur.

Modifications Required For C Applications

To build C applications byte-aligned with Ingres, a number of files require modification. Any modifications made may need to be re-applied following the installation of an Ingres patch.

The first files to modify are the C header files supplied in the following directories:

```
II_SYSTEM: [INGRES.DEMO.API.ASC]
```

```
II_SYSTEM: [INGRES.DEMO.UDADTS]
```

```
II_SYSTEM: [INGRES.FILES]
```

At this time, the only header files that contain Ingres structure definitions need modification, these are:

```
II_SYSTEM: [INGRES.DEMO.API.ASC]ASC.H  
II_SYSTEM: [INGRES.DEMO.UDADTS]UDT.H  
II_SYSTEM: [INGRES.FILES]ABFURTS.H,  
II_SYSTEM: [INGRES.FILES]EQSQLCA.H,  
II_SYSTEM: [INGRES.FILES]EQSQLDA.H,  
II_SYSTEM: [INGRES.FILES]FRAME2.H,  
II_SYSTEM: [INGRES.FILES]FRAME60.H,  
II_SYSTEM: [INGRES.FILES]FRAME61.H,  
II_SYSTEM: [INGRES.FILES]IIADD.H,  
II_SYSTEM: [INGRES.FILES]IIAPI.H,  
II_SYSTEM: [INGRES.FILES]OSLHDR.H,  
II_SYSTEM: [INGRES.FILES]RAAT.H,  
II_SYSTEM: [INGRES.FILES]SPATIAL.H
```

On the first line in each of the above files add:

```
#pragma member_alignment save
```

```
#pragma member_alignment
```

On the last line in each of the above files add:

```
#pragma member_alignment restore
```

Note: The "#" of the #pragma instruction *must* be the first character on the line.

The purpose of these pragmas is to direct the compiler to naturally align the elements of the defined structures, then to restore the alignment strategy used before the header file was included.

One further change is required to allow Application-By-Forms and Vision applications to successfully build with unaligned code. In `II_SYSTEM:[INGRES.FILES]DCC.COM`, replace the line

```
$ cc/standard=vaxc/float=ieee_float/nooptimize/nolist
```

with:

```
$ cc/NOMEMBER_ALIGNMENT/GRANULARITY=BYTE -  
/standard=vaxc/float=ieee_float/nooptimize/nolist
```

Modifications Required For COBOL Applications

To achieve the same result for embedded COBOL applications, the following statements must be added to these files:

```
II_SYSTEM:[INGRES.FILES]ESQLCA.COB, II_SYSTEM:[INGRES.FILES]ESQLDA.COB
```

On the first line of the above files, add:

```
*DC SET ALIGNMENT
```

On the last line of the above files, add:

```
*DC END-SET ALIGNMENT
```

The `II_SYSTEM:[INGRES.FILES]UTCOM.DEF` file requires the removal of the qualifier `"/alignment=padding"` from the COBOL compile statements.

Appendix A: Upgrading from Ingres 6.4

This appendix describes special considerations when upgrading from Ingres 6.4.

Regardless of the upgrade method you are using, you should perform the tasks described in Considerations for Ingres 6.4 (see page 79).

If you are using the unload/reload method to upgrade from Ingres 6.4, follow the instructions in How You Upgrade from Ingres 6.4 Using Unload/Reload (see page 86).

If you are using the upgradedb method to upgrade from Ingres 6.4, you can follow the procedure in the chapter "Upgrading Using Upgradedb." If you have difficulties with that procedure in your testing, you can use the process described in Alternate Upgrade Procedure (see page 96).

This appendix also lists Ingres 6.4 parameters and their corresponding names in newer releases.

Considerations for Ingres 6.4

There are additional considerations when loading Ingres 6.4 databases and applications into the new development installation. These considerations include application preparation and system preparation.

Application Preparation

After successfully creating databases and applications in the new Ingres development installation, you should check for the following additional application issues.

- Semantics change in the UPDATE...FROM statement
- Decimal constant semantics change
- Greater sensitivity to BYREF errors
- Journaling on by default
- Greater sensitivity to arithmetic errors
- 4GL TABLE_KEY type conversions
- User-defined data type changes

UPDATE . . . FROM Semantics Change

In Ingres 6.4/05 and earlier, the “ambiguous replace” test allowed an update using the UPDATE...FROM statement if each target row was being updated with an unambiguous value. Ingres 6.4/06 and higher releases test for multiple FROM rows and generate an ambiguous replace error message even if all the FROM rows generate the same replacement value.

For example, Ingres 6.4/05 and earlier allowed the following update:

```
UPDATE    table_1
FROM      table_2
SET       column_3 = 3;
```

even though there is no WHERE qualification joining the tables, since the replacement value was non-ambiguous. In later releases, an “ambiguous replace” error message displays.

The recommended approach for this semantics change is to review all applications for ambiguous updates and change them to use EXISTS or IN, instead of a join. If this is not feasible, the original UPDATE . . . FROM handling can be restored by setting the DBMS parameter “ambig_replace_64compat” to ON in Configuration-By-Forms.

Decimal Constant Semantics Change

With the introduction of the DECIMAL data type, fixed-point literals such as 1.0 are now considered DECIMAL, rather than FLOAT.

Typically, this does not matter, as Ingres does appropriate type conversions. However, it is important when doing a CREATE TABLE . . . AS SELECT with a constant in the SELECT result list.

For example:

```
CREATE TABLE table_1
  AS SELECT column_1, column_2, column_3=1.0
  FROM table_2;
```

In Ingres 6.4, the column_3 is created as FLOAT8; in Ingres it is created as a DECIMAL(2,1) column. This may result in overflow in an application.

The recommended approach is to examine uses of fixed-point constant usage in applications and change them to floating point constants, or add an explicit FLOAT8 type conversion.

A less thorough but easier alternative is to set the environment variable II_NUMERIC_LITERAL to FLOAT, as follows:

```
setenv II_NUMERIC_LITERAL FLOAT
```

Ingres then interprets fixed-point constants as floats rather than decimals. If you decide to use II_NUMERIC_LITERAL, it will be necessary for **every** user of the applications to set II_NUMERIC_LITERAL in their environment.

Greater Sensitivity to BYREF Errors

Ingres 6.4 4GL programs are insensitive to length and type errors when returning BYREF values to a calling program. Ingres is more sensitive to return values that are too long or the wrong type. In some cases, this can result in programs aborting and segmentation violations. The cure is to ensure that the called and calling routines return values of compatible length and type.

An as interim fix, an environment variable can be set to cause the 4GL runtime system to pass parameters the way 6.4 did: all integers forced to 4-byte, all floats forced to 8-byte. Character string passing is not affected. The environment variable setting is:

```
setenv II_PARAM_PASSING FORCEMAX
```

Journaling On by Default

In Ingres 6.4, if a database was journaled, a newly-created table would not be journaled unless `WITH JOURNALING` was explicitly stated.

In Ingres, journaling is on by default. This means that if an application creates temporary tables, those tables will be journaled; this may consume more system resource, resulting in Ingres applications running more slowly than expected.

You can turn default journaling off by changing the Configuration-By-Forms parameter `"default_journaling."` Alternative options are to issue a `SET NOJOURNALING` statement at the beginning of an application, create temporary tables `WITH NOJOURNALING`, or use session tables.

Greater Sensitivity to Arithmetic Errors

Ingres 6.4 ignores a number of arithmetic error conditions (such as floating point overflow and divide-by-zero). Ingres correctly reports arithmetic errors on all platforms. If an application generates arithmetic exceptions when tested with Ingres, it is probable that the application had problems in Ingres 6.4 that were not reported. The application must be corrected.

4GL TABLE_KEY Type Conversions

Conversion of 4GL VARCHAR variables to the TABLE_KEY type gives length errors. Avoid this by converting to char first:

```
TABLE_KEY(CHAR(varcharVariable))
```

Some 6.4 releases of 4GL had problems with variables of type TABLE_KEY. If you were doing type conversions to avoid the use of TABLE_KEY variables, consider removing the conversion altogether and using the TABLE_KEY type directly.

User-Defined Data Type Changes

If you are using Object Management Extension to declare user-defined data types in the server, be aware of some changes in calling sequences. For details, see the *Object Management Extension User Guide*.

Application Preparation Summary

Many of the changes required for Ingres are backward compatible with Ingres 6.4. Make application changes in the Ingres 6.4 installation, and bring them forward to the Ingres installation for testing. In this way, you do not have to freeze application development while preparing for Ingres.

At this stage, resist the temptation to make Ingres-specific application changes. While an outer join or a session temp table may enhance performance, there is plenty of time to add performance enhancements *after* the upgrade.

System Preparation

Take the following steps to prepare your system:

- Change customized start and stop shell scripts to reflect new commands
- Change shell scripts that use `ingprenv1` environment variable
- Carry forward any changes to archiver exit script
- Change transaction log parameter settings

Ingres Startup and Shutdown

Ingres uses new commands for startup and shutdown: `ingstart` and `ingstop` instead of `iistartup` and `iishutdown`. If you have customized shell scripts that start and stop Ingres, you must change them. Verify the changes in the development Ingres installation and have the revised scripts ready for the production environment at time of upgrade.

If you are running multiple DBMS servers with Ingres 6.4, you should be able to simplify your startup and shutdown procedures. Ingres supports multiple DBMS servers directly from the Ingres configuration.

`ingprenv` Replaces `ingprenv1`

In Ingres, the `ingprenv` command replaces the Ingres 6.4 `ingprenv1` command, which displayed one Ingres environmental variable. Shell scripts that use `ingprenv1` must be changed.

It is possible to recreate `ingprenv1` as follows:

```
echo 'exec $II_SYSTEM/ingres/bin/ingprenv $*' >/usr/local/bin/ingprenv1
chmod +x /usr/local/bin/ingprenv1
```

Archiver Exit Shellscript

Ingres has a sample Archiver exit script, `acpexit.def`. If the Ingres 6.4 `acpexit` script was customized, you must carry over these changes to the Ingres installation.

For information about the `acpexit` script, see the *System Administrator Guide*.

Transaction Log Size

Generally, Ingres uses less transaction log file space than Ingres 6.4. A few operations may use more (for example, `MODIFY TO MERGE`). To allow for its improved logging algorithms, Ingres reserves transaction log space that it may not actually write.

The force-abort limit cannot be set as close to log-full as was possible in Ingres 6.4.

If your Ingres 6.4 transaction log was barely large enough, it may be advisable to increase the size before or during the upgrade.

Unload/Reload Procedure for Upgrading from 6.4

The unload/reload upgrade avoids the `upgradedb` program (except for `iidbdb`), in favor of unloading the Ingres 6.4 databases to flat files, recreating the databases under Ingres, and then reloading the databases. This approach has the advantage of starting with clean databases, but requires more time and disk space than does the `upgradedb` method.

Note: Databases using the system-maintained logical key feature are best upgraded using `upgradedb`. Tables that contain `SYSTEM_MAINTAINED table_key` or `object_key` columns cannot be safely unloaded and reloaded without additional work. The reload step generates all new logical key values. If other tables reference the logical key columns, the new values must be manually propagated to those tables.

Unload/Reload Upgrade Types

You must choose one of the following variations of the unload/reload procedure:

- In-place upgrade, which replaces the 6.4 installation with the new Ingres installation. The master database (iiddb) is upgraded with upgradedb, even though other databases are unloaded and reloaded. Because the iiddb remains, all your locations, users, groups, and roles still exist in the new installation.
- Clean install upgrade, which leaves the 6.4 installation alone. Ingres is installed into a completely new installation. (The new installation may even be on a different machine.) When performing a clean install upgrade, you must take extra steps to recreate locations and move users, groups, and roles from the 6.4 installation to the new one.

Front-end Catalogs and the Upgradefe Program

The hardest part of the unload/reload upgrade is dealing with the front-end catalogs. These catalogs are unloaded in Ingres 6.4 format, and cannot be loaded into an Ingres database. To circumvent this problem, the Ingres database is created without front-end catalogs. The catalogs are then loaded in the Ingres 6.4 format and upgraded using the upgradefe program.

How You Upgrade from Ingres 6.4 Using Unload/Reload

To upgrade from Ingres 6.4 using the unload/reload procedure, follow this process.

Note: In this procedure, the notation **[Each DB]** means: "For each database, not including the iidbdb, become the DBA for that database, **cd** to the unload directory for the database created in Step 1, and perform this step." If using Ingres Star, include the coordinator database in the list of databases. Steps that apply to a particular upgrade type only (that is, in-place upgrade or clean install upgrade) are marked accordingly.

1. [Each DB including iidbdb] Create Unload Directory (see page 51).
2. [Each DB] Run Unloaddb (see page 52).
3. [Each DB] Check for Obsolete Users (see page 87).
4. [Each DB including iidbdb] (Optional) Checkpoint the Database (see page 53).
5. Disable User Access (see page 38).
6. Shut Down Ingres and Back Up System (see page 40).
7. [Each DB] Unload the Database (see page 54).
8. [Each DB] (Optional) Print Optimizer Statistics (see page 55).
9. [Each DB] Record Database Information (see page 41).
10. Record Database Privileges (see page 88).
11. Save Users, Groups, and Roles (see page 89).
12. [Each DB] Destroy the Database (see page 57).
13. Clean iidbdb Database (see page 90).
14. Record Ingres Configuration (see page 90).
15. Shut Down Ingres (see page 91).
16. Disable Ingres Startup (see page 59).
17. Preserve Site Modifications (see page 42).
18. Fix Logins (see page 91).
19. Save Ingres Settings (see page 91).
20. Clean Up Ingres 6.4 (see page 92).
21. Create Work Location (see page 92).
22. Install Ingres (see page 60).
23. Create imadb Database (see page 45).
24. Restore Site Modifications (see page 62).

25. Configure Ingres (see page 93).
26. Set Up Ingres Net (see page 62).
27. Start Ingres (see page 45).
28. Recreate Users, Groups, and Roles (see page 94).
29. Recreate Locations (see page 64).
30. [Each DB] Recreate the Database (see page 64).
31. [Each DB] Extend the Database (see page 64).
32. Recreate Database Privileges (see page 95).
33. [Each DB] Fix FE Reload Script (see page 95).
34. [Each DB] Reload the Database (see page 66).
35. [Each DB] Upgrade Front-End Catalogs (see page 67).
36. [Each DB] Reapply Optimizer Statistics (see page 67).
37. [Each DB including iidbdb] Checkpoint the Database (see page 47).
38. Install Upgraded Applications (see page 47).

The sections that follow provide details on steps that differ from those described previously in this guide.

Check for Obsolete Users

Old databases may have objects created by users who no longer exist. Check for obsolete users for each database.

To check for obsolete users:

1. Examine the scripts created by unloaddb earlier in the upgrade procedure.
Each script contains one line for each user who owns a database object.
2. Make sure that all users listed are valid.
3. If obsolete users are found, delete the relevant lines from the scripts.
4. Delete the cp{user}.in and cp{user}.out files.
5. Go into the database and clean out these unwanted objects.

Record Database Privileges

To record database privileges

1. As the installation owner, change directories to the unload directory for iidbdb created in Step 1 of this upgrade procedure.
2. Run the following SQL to save private database access lists and user database privileges:

```
sql iidbdb
\script dbaccess.out
select dbname, username
from iidbaccess
order by dbname, username
\go
\script
\script dbprivs.out
select *
from iidbprivileges
where database_name <> ''
order by database_name, grantee_name
\go
\script
\quit
```

This procedure creates two files, dbaccess.out and dbprivs.out.

Save Users, Groups, and Roles

Note: This step is required only for a clean-install upgrade.

To save users, groups, and roles

1. As the installation owner, change directory to the iiddb unload directory created in Step 1 of the upgrade procedure.
2. Run the following SQL to save users, groups, and roles:

```
sql iiddb
create table unload_tmp as
select name,status,default_group
from iiuser
where name not in ('ingres','$ingres','root')
\go
copy unload_tmp (
    name=c0comma,status=c0comma,default_group=c0nl
) into 'users.out'
\go
drop unload_tmp;commit
\go

copy iiusergroup (
    groupid=c0comma,groupmem=c0nl
) into 'groups.out'
\go

copy iirole(
    roleid=c0nl
) into 'roles.out'
\go
\quit
```

Clean iidbdb Database

Note: This step is required only for an in-place upgrade.

To clean the iidbdb database, become the installation owner and run the following steps against the master database iidbdb.

Note: It is assumed that there are no objects created by users in the iidbdb.

```
statdump '-u$ingres' -zdl iidbdb

sysmod -s iidbdb

verifydb -mrun -sdbname iidbdb -opurge

verifydb -mrun -sdbname iidbdb -odbms

ckpdb -s -j iidbdb
```

The verifydb command may issue the following messages, which you can ignore:

S_DU1611_NO_PROTECTS iirelation indicates that there are protections for table (owner), but none are defined.

S_DU0305_CLEAR_PRTUPS Recommended action is to clear protection information from iirelation, and S_DU1619_NO_VIEW iirelation indicates that there is a view defined for table (owner), but none exists.

S_DU030C_CLEAR_VBASE Recommended action is to clear view base specification from iirelation.

You can also ignore the “patch warning” message that warns of the loss of user tables in “runinteractive” mode. This mode will not be used.

Record Ingres Configuration

To record Ingres configuration:

1. As the installation owner, execute the “showrcp” command.
2. Record the contents of the rundbms.opt file found in \$II_SYSTEM/ingres/files.

You will use this information later as a guide for configuring Ingres. The Ingres installation procedure does not preserve the Version 6.4 parameter settings. During installation, the ingres/files directory is deleted, so save the information.

Shut Down Ingres

Shut down Ingres with the `iishutdown` command.

Fix Logins

To fix logins:

1. If necessary, make sure that the login for the installation owner sets `LD_LIBRARY_PATH` or the platform equivalent.
2. Make sure that the login for the user does not use `ingpenv1`, or install your `ingpenv1` substitute, as described in `ingpenv1 Replaces ingpenv1` (see page 83).
3. Check all your database owner (DBA) logins to ensure that they are properly set up for Ingres, with `LD_LIBRARY_PATH` or equivalent, and no use of `ingpenv1`.
4. Define `LD_LIBRARY_PATH` or equivalent for the installation owner user session that you will use to install and upgrade Ingres.
5. If you are doing a clean-install upgrade on a different machine, make sure that your login fixes are applied to the new machine, not to the old one.

Save Ingres Settings

Note: This step is required only for an in-place upgrade.

The upgrade runs more smoothly if the Ingres 6.4 executables, control files, and environment variables are deleted. However, you do not want to lose your installation ID and default locations. These are kept in a file named `symbol.tbl`.

Copy `$II_SYSTEM/ingres/files/symbol.tbl` to a safe area not in the Ingres directory tree.

Clean Up Ingres 6.4

Note: This step is required only for an in-place upgrade.

To guarantee a clean environment for Ingres:

1. Invoke the following commands:

```
cd $II_SYSTEM/ingres  
rm -rf bin files lib utility dbtmpl version.rel admin  
mkdir files
```

2. Copy your saved symbol.tbl back into the \$II_SYSTEM/ingres/files directory.

Create Work Location

Note: This step is required only for an in-place upgrade.

The Ingres installation procedure asks for a location for temporary files and sorting, and creates the directories if they do not exist. However, you should create this location manually because some versions of the installation procedure may not properly set the protections for the directories, which can cause upgradedb to fail when upgrading the iidbdb database.

For information on placement of your default work location, see the *Database Administrator Guide*.

As the installation owner, assume a work location called /mywork:

UNIX:

```
/mywork:  
mkdir /mywork/ingres  
mkdir /mywork/ingres/work  
mkdir /mywork/ingres/work/default  
mkdir /mywork/ingres/work/default/iidbdb  
chmod 755 /mywork/ingres  
chmod 700 /mywork/ingres/work  
chmod 777 /mywork/ingres/work/default  
chmod 777 /mywork/ingres/work/default/iidbdb
```

Windows:

```
md \mywork\ingres  
md \mywork\ingres\work  
md \mywork\ingres\work\default  
md \mywork\ingres\work\default\iidbdb
```

Restore Site Modifications

Restore any site-specific files that you copied in the step Preserve Site Modifications.

If the checkpoint template file `cktmpl.def` has been modified, the modifications may need to be carried forward into Ingres. The `cktmpl.def` from Ingres 6.4 cannot be used with Ingres, as the file format has changed. This means that you must recreate the changes using the Ingres 6.4 `cktmpl.def` as a guide. See the Ingres 6.4 *Database Administrator's Guide*.

If the archiver exit script `acpexit` was changed in Ingres 6.4, you must make the changes to the Ingres template (`acpexit.def`), and then move that file to `$II_SYSTEM/ingres/files/acpexit`.

Configure Ingres

Run Configuration-By-Forms (CBF) and initially configure the Ingres installation. Use the `rundbms.opt` and `showrcp` information from Ingres 6.4 as a guideline. For information about CBF and the various tuning parameters, see the *System Administrator Guide*.

Information on the correlation between 6.4 and Ingres parameter names, is described in Corresponding Parameter Names (see page 104).

Derived parameters are recalculated when values they depend on are changed. If derived parameters are set, they can be “protected” against change.

Ingres versions from 2.0 through 2.6 may calculate very large default lock and resource limits parameters. Check the `lock_limit` and `resource_limit` settings, and consider reducing these limits to the Ingres 6.4 settings.

On OS-thread platforms, do not turn on `async_io`; and do not declare the `II_NUM_SLAVES` Ingres variable.

Ingres supports larger `qef_sort_mem` values than Ingres 6.4. Ingres may not need as much `qsf_memory` as did Ingres 6.4. OS-thread platforms should not reduce `quantum_size`, as it does not improve performance on those platforms.

Recreate Users, Groups, and Roles

Note: This step is required only for a clean-installation upgrade.

If your 6.4 installation has only a few Ingres users defined, you should use the `accessdb` utility or the `CREATE USER` SQL statement to recreate those users in the Ingres installation. As a guide, use the file `users.out` or refer to the 6.4 installation.

If you have many users, the following procedure recreates them in mass.

As the installation owner, change directory to your `iidbdb` `unloaddb` directory where you stored the files from the step `Save Users, Groups, and Roles`.

Run this SQL:

```
sql '-u$ingres' iidbdb
copy iiuser(name=c0comma,status=c0comma,default_group=c0nl)
from 'users.out'
\go
update iiuser
set default_priv = status, user_priv = status,
    flags_mask = case when default_group <> ' ' then 28 else 24 end
where user_priv = 0 and flags_mask = 0;
\go
copy iiusergroup(groupid=c0comma,groupmem=c0nl)
from 'groups.out'
\go
commit
\go
\quit
```

Windows: Omit the quotes from the `sql` command line. 🚩

Ingres has new user privileges that do not exist in 6.4. If you recreate users using the above bulk load procedure, you should review the added users with `accessdb` to make sure that all user privileges are set the way you want them. In particular, review the definitions for any 6.4 “superusers.”

Ingres handles the “update system catalog” privilege differently than did 6.4. You must explicitly grant this privilege to the Ingres user after you recreate it, with a grant statement, as follows:

```
grant update_syscat on current installation to user-name
```

If your 6.4 installation had roles defined, recreate them with the `ADD ROLE` SQL statement. Use the file `roles.out` as a guide. Roles cannot be reliably bulk-loaded from the 6.4 installation, so you must recreate them by hand. After you recreate each role, issue the following SQL statement:

```
grant rolename to public; commit
```

This allows the role to be used in the same manner as in 6.4.

Recreate Database Privileges

To recreate database privileges:

1. As the installation owner, change to the iidbdb unloaddb directory.
2. Refer to the file dbaccess.out created in the step Record Database Privileges.
3. Start an iidbdb Terminal Monitor session:

```
sql iidbdb
```
4. For each database and user combination listed in dbaccess.out, issue the statement:

```
grant access on database database-name to username; commit
```
5. Review the file dbprivs.out created in the step Record Database Privilege.
Each row describes one or more database privileges given to the user *grantee-name*. A Y or N in a privilege column indicates the specific privilege. (A U in a column means Unchanged.)
6. For each row, issue the statement

```
grant privilege on database database-name to grantee-name;commit
```


If the privilege column is N, grant *noprivilege* instead of *privilege*.
7. When finished, use **\quit** to exit the iidbdb session.

If you have defined many privileges, or recreated many users, groups, or roles, you should run sysmod on the iidbdb, which will accelerate query processing. Issue the sysmod command, as follows:

```
sysmod iidbdb
```

Fix FE Reload Script

Because the new database was not created with front-end catalogs, it is not necessary to drop them.

To fix the front-end reload script, for each database:

1. Open the file cp_ingres.in.
2. Delete the following lines:

```
\include/ing64/ingres/files/iiud.scr  
\include/ing64/ingres/files/iiud64.scr
```


Note: The directory path may differ.
3. Save the file.

Alternate Upgradedb Procedure

The upgradedb utility in Ingres 2006 is enhanced to allow 6.4 databases to be upgraded using the standard procedure in the chapter “Upgrading Using Upgradedb.” Due to the many enhancements made since Ingres 6.4, the upgradedb utility performs an intricate task when upgrading a 6.4 database.

If you encounter upgradedb problems in your testing, or if you prefer a safer (but more complex) procedure, use the alternate upgradedb procedure in this section. This modified procedure is designed so that the upgradedb utility has to perform as little work as possible, so that it will correctly handle the upgrade tasks.

In the procedure, each database is prepared by dropping all objects that can be recreated, that is, by dropping everything but the base tables. Each base table must be checked to make sure it is valid and has no internal damage. After the upgrade, the various database objects are recreated.

The procedure directs you to cut and paste the output of unloaddb to generate SQL that recreates database objects and storage structures. If procedures already exist to recreate database objects and storage structures, you can use these instead. Make sure, however, that the procedures recreate all the relevant objects. If users or applications dynamically create database objects, it may be safer to cut and paste from unloaddb.

The alternate upgradedb procedure assumes that you can become any user who owns objects in any database (using login or UNIX “su”). If this is not feasible, you can run as the installation owner (default user ID is ingres), and use the -u{user} flag to pretend to be that user whenever you must run an Ingres command.

How You Upgrade from Ingres 6.4 Using Upgradedb (Alternate)

To upgrade from Ingres 6.4 using the alternate upgradedb procedure, follow this process.

Note: In this procedure, the notation **[Each DB]** means: "For each database, not including the iidbdb, become the DBA for that database, **cd** to the unload directory for the database created in Step 1, and perform this step." Do not include the iidbdb or Ingres Star databases unless instructed. If using Ingres Star, remember to include the coordinator database in the list of databases.

1. [Each DB including Ingres Star DDBs] Create Unload Directory (see page 98).
2. [Each DB including Ingres Star DDBs] Run Unloaddb (see page 99).
Note: You can omit Steps 2 through 4 if procedures already exist to recreate all database objects and storage structures. However, it will be necessary to make the appropriate changes to the oi_prep.sh script-see the step Remove Non-table Objects-for re-modifying all tables.
3. [Each DB including Ingres Star DDBs] Check for Obsolete Users (see page 87).
4. [Each DB] Edit the Unloaddb Output (see page 100).
5. [Each DB including iidbdb] (Optional) Checkpoint the Database (see page 53).
6. Disable User Access (see page 38).
7. Shut Down Ingres and Back Up System (see page 40).
8. [Each DB] (Optional) Print Optimizer Statistics (see page 55).
9. [Each DB] Remove Non-table Objects (see page 101).
10. [Each DB] Record Database Information (see page 41).
11. Clean iidbdb Database (see page 90).
12. [Each DB including iidbdb] Checkpoint and Turn Off Journaling (see page 102).
13. Record Ingres Configuration (see page 90).
14. Shut Down Ingres (see page 91).
15. Disable Ingres Startup (see page 59).
16. Preserve Site Modifications (see page 42)
17. Fix Logins (see page 91).
18. Save Ingres Settings (see page 103).
19. Clean Up Ingres 6.4 (see page 92).

20. Create Work Location (see page 92).
21. Install Ingres (see page 60).
22. Create imadb Database (see page 45).
23. Restore Site Modifications (see page 62).
24. Start Ingres (see page 45).
25. Run Upgradedb Utility (see page 46).
26. Configure Ingres (see page 93).
27. Set Up Ingres Net (see page 62).
28. [Each DB] Recreate Objects (see page 103).
29. [Each DB] Reapply Storage Structures (see page 103).
30. [Each DB] Reapply Optimizer Statistics (see page 67).
31. [Each DB including iidbdb] Checkpoint the Database (see page 47).
32. Install Upgraded Applications (see page 47).

The sections that follow provide details on steps that differ from those described previously in this guide.

Create Unload Directory

You must create a directory to hold scripts, but no data. Make the directory writable by anyone. The disk space needed is a maximum of 1 MB per directory.

To create a directory, issue the following commands for each database, including the Ingres Star databases:

UNIX:

```
mkdir /someplace/dbname  
chmod 777 /someplace/dbname
```

Windows:

```
mkdir d:\someplace\dbname
```

Run Unloaddb

Note on Steps 2 through 4: You can omit Steps 2 through 4 if procedures already exist to recreate all database objects and storage structures. However, it will be necessary to make the appropriate changes to the `oi_prep.sh` script—see the step Remove Non-table Objects—for re-modifying all tables.

Run `unloaddb` against each database. The `unloaddb` command does not unload the database; it simply creates scripts. You can edit these scripts to produce a collection of scripts that recreate various database objects and storage structures.

For Ingres Star databases, unload the CDB in the same way as for a local database. For a DDB, use `unloaddb/star`.

For a regular DB or CDB, issue this command:

```
unloaddb dbname
```

For an Ingres Star DDB, issue this command:

```
unloaddb dbname/star
```

Edit the Unloaddb Output

The unloaddb output must be modified for recreating just the database objects and storage structures.

To edit the unloaddb output, manually edit each cp{user}.in file that unloaddb created to extract the following statements:

- Create rule statements into a file named {user}_rule.sql
- Create procedure related statements into {user}_dbp.sql
- Create dbevent related statements into {user}_event.sql
- Modify statements into {user}_modify.sql
- Modify and create index statements into {user}_modindex.sql
- All other non-base-table related statements into {user}_grantview.sql.
This file will contain grants, QUEL permits, QUEL integrities, and view definitions.

For UNIX, the extract_unloaddb.sh shellsript is available that extracts one user's object definitions. The script is available on the Ingres Technical Support web site.

Note: The \$ingres user should not own any non-catalog objects, so do not process the cp_ingre.in file that unloaddb creates.

As a result of this step, SQL scripts are created that can recreate any database object or storage structure owned by any user in any database.

Remove Non-table Objects

The purpose of removing non-table objects is to reduce the database to base tables.

Some database objects such as procedures and views can be very complicated, and some past versions of upgradedb did not always process them successfully. Additionally, processing of some objects (grants in particular) is slow and expensive. Dropping the grants and later recreating them avoids any possible failure due to lack of transaction log space.

Note: Do not process Ingres Star distributed databases.

To remove non-table objects

1. Drop all non-table objects from the database including:
 - Optimizer statistics
 - Views
 - Rules
 - Database procedures
 - Database events
 - Secondary indexes
 - Grants and QUEL permits
 - QUEL integrities
2. Modify all tables to heap.

UNIX:

To perform this step automatically

1. Use the shell script `oi_prep.sh`. The script is available from Ingres Technical Support.

Using the C shell, issue this command:

```
oi_prep.sh dbname |& tee oi_prep.log
```

If there are any dependent views, "drop" errors messages may be reported on those views (`oi_prep.sh` does not drop views in reverse dependency order); ignore the "drop" errors

2. Run `verifydb` checks against the database.

The `verifydb -odbms` command may output the following messages, which you can ignore:

```
S_DU1611_NO_PROTECTS iirelation indicates that there are protections for  
table (owner), but none are defined.
```

S_DU0305_CLEAR_PRTUPS Recommended action is to clear protection information from iirelation, and S_DU1619_NO_VIEW iirelation indicates that there is a view defined for table (owner), but none exists.

S_DU030C_CLEAR_VBASE Recommended action is to clear view base specification from iirelation.

Also ignore the "patch warning" message that warns of the loss of user tables in "runinteractive" mode. This mode will not be used.

3. If some databases produce a "verifydb failed" message and then abort, run the Terminal Monitor with the update system catalogs flag, as follows:

```
sql +U dbname  
  
SELECT * FROM iistatistics;\go
```

No rows should be returned. If there are rows, this is the probable cause of the verifydb problem.

4. If there are rows, delete them, as follows:

```
DELETE FROM iistatistics;COMMIT;\go\quit
```

5. Rerun the verifydb command as shown at the end of the oi_prep.sh.
6. If error messages are returned from verifydb, correct the problems before continuing. Contact Ingres Technical Support for help, if necessary. ■

Checkpoint and Turn Off Journaling

For each database, including the iibdadb, checkpoint each database and turn off journaling. Then save the configuration file.

The upgradedb process turns off journaling, so it is best to turn it off now. If upgradedb fails, you can use this checkpoint to recover and try again.

To checkpoint and turn off journaling

1. Checkpoint each database, using the ckpdb command with -j option to turn off journaling. Issue the following command:

```
ckpdb -d -j dbname
```

Note: For the iibdadb, use the ckpdb -s option. The iibdadb database does not have an "unload" directory.

2. Save the configuration file stored in the dump area after each checkpoint. The configuration file is small. Issue the following command:

```
cp $II_DUMP/ingres/dmp/default/dbname/aaaaaaaa.cnf {somewhere secure}
```

Save Ingres Settings

Save your installation ID and default locations, which are kept in a file named `symbol.tbl`. Copy `$II_SYSTEM/ingres/files/symbol.tbl` to a safe area not in the Ingres directory tree.

Recreate Objects

Using the scripts generated by the step Edit the Unloaddb Output, recreate the views and other database objects.

Recreate objects in the following sequence:

1. Views, QUEL integrities, and grants:

```
sql -uuser dbname <user_grantview.sql
```

2. Dbevents:

```
sql -uuser dbname <user_event.sql
```

3. Database procedures:

```
sql -uuser dbname <user_dbasp.sql
```

4. Rules:

```
sql -uuser dbname <user_rule.sql
```

Remember to run all four scripts for each user who owns objects in each database.

If your application system has its own scripts to recreate database objects, you may use them instead of the unloaddb-generated scripts.

Reapply Storage Structures

For each `user_modindex.sql` script generated by the step Edit the Unloaddb Output, reapply storage structures and indexes:

```
sql -uuser dbname <user_modindex.sql
```

If your application system has its own scripts to reapply storage structures and create indexes, you may use them instead of the unloaddb-generated scripts.

Corresponding Parameter Names

The configuration system in Ingres 6.4 differs from that of subsequent releases, so you need to know how the Ingres 6.4 server parameters correspond to the new Ingres parameters.

All corresponding Ingres parameters listed here are found in the DBMS Server component. Ingres parameters that do not have any corresponding Ingres 6.4 parameters are not listed.

Parameters in 6.4 `rundbms.opt` File

The following table lists Ingres 6.4 parameters and their corresponding parameter names in the new Ingres.

Note: Parameters of type Cache are repeated for each cache page size.

Ingres 6.4 Parameter	Ingres Parameter	Type
active_sessions	active_limit	Derived
cache_name	cache_name	
connected_sessions	connect_limit	
cpu_statistics	cpu_statistics	Derived
cursors_per_session	cursor_limit	
database_count	database_limit	Derived
dblist	database_list	Databases
define	define_address	Derived
dmf.cache_size	dmf_cache_size	Cache, Derived
dmf.count_read_ahead	dmf_group_count	Cache, Derived
dmf.dbcache_size	dmf_db_cache_size	
dmf.flimit	dmf_free_limit	Cache, Derived
dmf.memory	dmf_memory	Cache, Derived
dmf.mlimit	dmf_modify_limit	Cache, Derived
dmf.scanfactor	dmf_scan_factor	Cache

Ingres 6.4 Parameter	Ingres Parameter	Type
dmf.size_read_ahead	dmf_group_size	Cache
dmf.tblcache_size	dmf_tbl_cache_size	
dmf.tcb_hash	dmf_hash_size	
dmf.wbend	dmf_wb_end	Cache, Derived
dmf.wbstart	dmf_wb_start	Cache, Derived
events	event_limit	
fast_commit	fast_commit	Derived
flatten	query_flattening (ON)	
image	image_name	
maximum_working_set	unix_maximum_working_set	
names	name_service (ON)	
noflatten	query_flattening (OFF)	
nonames	name_service (OFF)	
opf.active	opf_active_limit	Derived
opf.aggregate_flatten	qflatten_aggregate (ON)	Derived
opf.complete	opf_complete (ON)	
opf.cpubfactor	opf_cpu_factor	
opf.exactkey	opf_exact_key	
opf.memory	opf_memory	Derived
opf.noaggregate_flatten	qflatten_aggregate (ON)	Derived
opf.nocomplete	opf_complete (OFF)	
opf.nonkey	opf_non_key	
opf.rangekey	opf_range_key	
opf.repeatfactor	opf_repeat_factor	
opf.sortmax	opf_sort_max	
opf.timeoutfactor	opf_timeout_factor	
priority	unix_priority	
psf.memory	psf_memory	Derived
qef.qep_size	qef_qep_mem	

Ingres 6.4 Parameter	Ingres Parameter	Type
qef.sort_size	qef_sort_mem	
qsf.pool_size	qsf_memory	Derived
quantum	quantum_size	
rdf.max_tbls	rdf_max_tbls	
rdf.memory	rdf_memory	Derived
rdf.tbl_cols	rdf_tbl_cols	
rdf.tbl_idx	rdf_tbl_idx	
rule_depth	rule_depth	
scf.row_estimate	scf_rows	
server_class	server_class	
session_accounting	session_accounting	
shared_cache	cache_sharing (ON)	
sole_cache	cache_sharing (OFF)	
sole_server	sole_server	Derived
stack_size	stack_size	
write_behind	dmf_write_behind (see notes)	Cache

Notes on Specific DBMS Server Parameters

Note the following:

- The 6.4 QEF sorting algorithm is unsuited to large `qef_sort_mem` settings. All recent Ingres versions use a different sort that does not degrade with large `qef_sort_mem` settings. The 6.4 standard setting is much smaller than the Ingres default.
- Recent Ingres versions typically require significantly less `qsf_memory` than Ingres 6.4 does, perhaps as little as half. After upgrading, start with the same `qsf_memory` setting as Ingres 6.4, but monitor QSF memory usage with trace point QS501 and tune `qsf_memory` appropriately.
- The `quantum_size` parameter in an internal threads (slaves) installation is often set to a small number (50 to 100) to improve responsiveness. `Quantum_size` has a different meaning in an OS threads installation, where it should not be set to less than 300, or excessive polling of the session communications channel will occur. A `quantum_size` of 1000 is usually appropriate when OS threads are in use.
- The 6.4 `write_behind` parameter is a thread count. Starting with 2.5, the `dmf_write_behind` parameter is simply ON or OFF, and the server dynamically allocates threads. Prior to Ingres II 2.5, the `write_behind` parameter means the same as it did in 6.4.
- A `stack_size` of 64 KB is typical with 6.4. Recent Ingres versions use more stack, so the stack size should be set to 128 KB (or more, if sporadic session failures occur).
- 6.4 VMS installations can have a few additional non-UNIX parameters, which have the same or almost the same names in recent Ingres versions.

Locking and Logging System Parameters

These parameters are set with `iistartup -init`, or `rcpconfig`, in Ingres 6.4.

Ingres 6.4 Parameter	Ingres Parameter	Type
Log buffers in memory	<code>buffer_count</code>	Log
Transactions in the logging system	<code>tx_limit</code>	Log, Derived
Databases in the logging system	<code>database_limit</code>	Log, Derived
Maximum C.P. interval for invoking the archiver	<code>archiver_interval</code>	Log, Derived
Block size of the log file	<code>block_size</code>	Log
Log-full limit	<code>full_limit</code>	Log

Ingres 6.4 Parameter	Ingres Parameter	Type
Percentage of log for consistency point	cp_interval	Log, Derived
Force-abort limit	force_abort_limit	Log, Derived
Size of the lock hash table	hash_size	Lock, Derived
Size of the resource hash table	resource_hash	Lock, Derived
Maximum number of locks in the locking system	lock_limit	Lock, Derived
Maximum number of lock lists	list_limit	Lock, Derived
Maximum number of locks per transaction	per_tx_limit	Lock

Notes on Specific Logging and Locking Parameters

Note the following:

- There is no 6.4 equivalent to the Ingres log_writer parameter. Although the log_writer default is 1, it is usually advantageous to start your Ingres installation with log_writer set to 4 or 5. If you are using dual logging, double the setting.
- The default rule for computing lock_limit (and the new parameter resource_limit) tend to compute very high numbers-hundreds of thousands, or more. You can allow more locks than you did in 6.4. As an initial setting, a doubling of lock_limit is usually more than sufficient.
- Ingres 2006 requires at least 35 log buffers. The install or upgrade will raise the log buffer count to a minimum of 35.
- Configurator may compute a different archiver_interval than you used in 6.4. Carry over the 6.4 setting.

Appendix B: Keywords

This appendix lists Ingres keywords and the contexts in which they are reserved. You can use the lists in this appendix to avoid assigning object names that conflict with reserved words.

Note: The keywords in these lists do not necessarily correspond to supported Ingres features. Some words are reserved for future or internal use, and to provide backward compatibility.

Table Key

In the tables in this appendix, the column headings have the following meanings:

Non 6.4

Keywords not included in Ingres 6.4 keyword reserved lists

ISQL (Interactive SQL)

Keywords reserved by the DBMS

ESQL (Embedded SQL)

Keywords reserved by the SQL preprocessors

IQUEL (Interactive QUEL)

Keywords reserved by the DBMS

EQUEL (Embedded QUEL)

Keywords reserved by the QUEL preprocessors

4GL

Keywords reserved in the context of SQL or QUEL in Ingres 4GL routines

Reserved Single Keywords

The following single keywords are reserved.

Note: The ESQL and QUEL preprocessors also reserve forms statements.

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
abort		*	*	*	*	*	*
activate			*		*		
add		*	*	*			
addform			*		*		
after	*			*			*
all		*	*		*	*	
alter		*		*			
and		*	*		*	*	
any		*	*	*	*	*	
append					*	*	*
array	*			*			
as		*	*		*	*	*
asc		*		*			
asymmetric	*	*	*				
at		*	*	*	*	*	*
authorization		*	*				
avg		*	*	*	*	*	
avgu			*		*	*	
before				*			*
begin		*	*	*	*		*
between		*	*	*			
breakdisplay			*		*		
by		*	*	*	*	*	*
byref	*	*		*			*

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
call			*	*		*	*
callframe	*			*			*
callproc	*	*		*			*
cascade	*	*	*				
case	*	*	*	*			
cast	*	*					
check		*	*	*			
clear			*	*		*	*
clearrow			*	*		*	*
close		*	*		*		
coalesce	*	*					
collate	*	*	*				
column		*	*	*		*	
command			*			*	
comment	*			*			
commit		*	*	*			
committed	*	*	*	*			
connect			*				
constraint	*	*	*	*			
continue		*	*				
copy		*	*	*	*	*	*
copy_from	*	*					
copy_into	*	*					
count		*	*	*	*	*	
countu			*		*	*	
create		*	*	*	*	*	*
current		*	*				
current_user	*	*	*				
currval	*	*	*	*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
cursor		*	*				
cycle	*	*	*	*			
datahandler	*		*				
dbms_password	*		*	*			
declare		*	*	*			*
default	*	*	*	*			*
define	*	*			*		*
delete	*	*	*	*	*	*	*
deleterow			*	*		*	*
desc				*			
describe	*	*	*				
descriptor			*				
destroy					*	*	*
direct	*			*			*
disconnect			*				
display			*	*		*	*
distinct		*	*	*			
distribute	*				*		
do		*		*			*
down			*			*	
drop		*	*	*			
else		*		*			*
elseif		*		*			*
enable	*			*			
end		*	*	*	*	*	*
end-exec	*		*				
enddata			*			*	
enddisplay			*			*	

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
endfor		*	*	*			
endforms			*			*	
endif		*		*			*
endloop		*	*	*		*	*
endrepeat		*	*	*			
endretrieve						*	
endselect			*				
endwhile		*		*			*
escape		*	*				
except	*	*					
exclude	*				*		
excluding	*	*	*		*		
execute		*	*	*	*		
exists		*	*	*			
exit				*		*	*
fetch		*	*				
field			*			*	
finalize			*			*	
first		*	*	*			
for		*	*	*	*	*	
foreign	*	*	*				
formdata			*			*	
forminit			*			*	
forms			*			*	
from		*	*	*	*	*	*
full	*	*	*	*			
get	*			*			
getform			*			*	
getoper			*			*	

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
getrow			*			*	
global	*	*	*	*			
goto			*				
grant		*	*	*			
granted	*		*	*			
group		*	*	*			
having		*	*	*			
help			*		*	*	
help_forms	*			*			*
help_frs			*			*	
helpfile			*	*		*	*
identified			*	*			
if		*		*			*
iimessage	*		*			*	
iiprintf	*		*			*	
iiprompt	*		*			*	
iistatement	*					*	
immediate		*	*	*			*
import	*	*					
in		*	*	*	*	*	
include			*		*		
increment	*	*	*	*			
index		*	*	*	*	*	*
indicator			*				
ingres						*	
initial_user	*	*	*				
initialize			*	*		*	*
inittable			*	*		*	*
inquire_equel						*	

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
inquire_forms	*			*			*
inquire_frs			*		*		
inquire_ingres	*		*	*	*		*
inquire_sql			*	*			
insert		*	*	*			
insertrow			*	*	*		*
integrity		*	*		*		*
intersect	*	*					
into		*	*	*	*	*	*
is		*	*	*	*	*	*
isolation	*	*	*	*			
join	*	*	*				
key	*		*	*			*
leave		*	*	*			
left	*		*	*			
level	*	*	*		*	*	
like		*	*				
loadtable			*	*	*		*
local	*	*					
max		*	*	*	*	*	
maxvalue	*	*	*	*			
menuitem			*		*		
message		*	*	*	*		*
min		*	*	*	*	*	
minvalue	*	*	*	*			
mode	*			*			*
modify		*	*	*	*	*	*
module	*	*					
move	*				*		

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
natural	*	*	*				
next		*	*			*	
nextval	*	*	*	*			
nocache	*	*	*	*			
nocycle	*	*	*	*			
noecho	*			*			*
nomaxvalue	*	*	*	*			
nominvalue	*	*	*	*			
noorder	*	*	*	*			
not		*	*		*	*	
notrim			*			*	
null		*	*	*		*	*
nullif	*	*					
of		*	*	*	*	*	*
on		*	*		*	*	*
only	*	*	*	*	*		*
open		*	*		*		
option		*					
or		*	*		*	*	
order		*	*	*	*	*	*
out			*			*	
outer	*	*	*	*			
param						*	
partition	*		*				
permit		*	*		*		*
prepare		*	*				
preserve	*	*	*				
primary	*		*	*			
print			*		*	*	

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
printscreen			*	*		*	*
privileges		*					
procedure		*	*	*			*
prompt			*	*		*	*
public		*	*				
purgetable	*		*	*		*	*
putform			*			*	
putoper			*			*	
putrow			*			*	
qualification	*			*			*
raise	*	*		*			
range					*	*	*
rawpct	*	*	*	*			
read	*	*	*		*		
redisplay			*	*		*	*
references	*	*	*	*			
referencing		*		*			
register		*	*	*	*	*	*
relocate		*	*	*	*	*	*
remove		*	*	*		*	*
rename	*				*		
repeat		*	*	*		*	*
repeatable	*	*	*				
repeated			*	*			
replace					*	*	*
replicate	*				*		
restart	*	*	*	*			
restrict	*	*	*				
result	*		*				

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
resume			*	*		*	*
retrieve					*	*	*
return		*		*			*
revoke		*	*	*			
right	*		*	*			
role	*		*	*			
rollback		*	*	*			
row		*	*	*			
rows	*	*	*				
run	*			*			*
save		*	*	*	*	*	*
savepoint		*	*	*	*	*	*
schema	*	*	*				
screen			*	*		*	*
scroll			*	*		*	*
scrolldown			*			*	
scrollup			*			*	
section			*				
select		*	*	*			
serializable	*	*	*	*			
session	*	*	*	*			
session_user	*	*	*				
set		*	*	*	*	*	*
set_4gl	*			*			*
set_equel						*	
set_forms	*			*			*
set_frs			*			*	
set_ingres	*		*	*		*	*
set_sql			*	*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
sleep			*	*		*	*
some		*	*	*			
sort					*	*	*
sql		*					
start	*	*	*	*			
stop			*				
submenu			*			*	
substring		*	*				
sum		*	*	*	*	*	
sumu			*		*	*	
symmetric	*	*	*				
system	*			*			*
system_ maintained	*	*	*		*	*	
system_user	*	*	*				
table		*	*				
tabledata			*			*	
temporary	*	*	*				
then		*	*	*			*
to		*	*		*	*	*
type	*			*			
uncommitted	*	*	*	*			
union		*	*	*			
unique		*	*	*	*	*	*
unloadtable			*	*		*	*
until		*	*	*	*	*	*
up			*			*	
update		*	*	*	*		
user		*	*	*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
using		*	*				
validate			*	*		*	*
validrow			*	*		*	*
values		*	*	*			
view		*	*		*		*
when	*	*	*				
whenever			*				
where		*	*	*	*	*	*
while		*					*
with		*	*	*	*	*	*
work		*		*			
write	*	*	*	*			

Reserved Double Keywords

The following double keywords are reserved.

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUEL	EQUEL	4GL
add privileges	*			*			
after field	*			*			*
alter default	*		*	*			
alter group		*	*	*			
alter location	*	*	*	*			
alter profile	*	*					
alter role		*	*	*			
alter security_audit	*	*	*	*			
alter_sequence	*	*	*	*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
alter table	*		*	*			
alter user	*	*	*	*			
array of	*			*			
base table structure		*					
before field	*			*			*
begin declare	*		*				
begin exclude	*		*				
begin transaction		*	*	*	*	*	*
by group	*			*			
by role	*	*		*			
by user	*	*		*			
call on	*			*			
call procedure	*			*			
class of	*			*			
clear array	*		*				
close cursor			*		*	*	
comment on	*	*	*	*			
connect to	*			*			
copy table	*			*			
create dbevent		*	*	*			
create domain	*		*				
create group		*		*			
create integrity	*	*		*			
create link		*	*				
create location	*	*	*	*			
create permit	*	*		*			
create procedure	*			*			
create profile	*	*	*	*			
create role		*	*	*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
create rule		*	*	*			
create security_alarm	*	*	*	*			
create sequence	*	*	*	*			
create synonym	*	*	*	*			
create user	*	*	*	*			
create view	*	*		*			
cross join	*	*	*	*			
curr value	*	*					
current installation	*			*			
current value	*	*	*	*			
define cursor					*		
declare cursor						*	
define integrity					*	*	*
define link						*	
define location					*		
define permit					*	*	*
define qry		*			*		*
define query		*			*		
define view					*	*	*
delete cursor					*	*	
describe form	*		*				
destroy integrity					*	*	*
destroy link						*	
destroy permit					*	*	*
destroy table						*	
destroy view	*						*
direct connect			*	*		*	*
direct disconnect			*	*		*	*
direct execute			*	*			*

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
disable security_audit	*	*	*	*			
disconnect current	*			*			
display submenu	*			*			*
drop dbevent		*	*	*			
drop domain	*		*				
drop group		*		*			
drop integrity	*	*		*			
drop link		*	*	*			
drop location	*	*	*	*			
drop permit	*	*		*			
drop privileges	*			*			
drop procedure	*			*			
drop profile	*	*	*	*			
drop role		*	*	*			
drop rule		*	*	*			
drop security_alarm	*	*	*	*			
drop sequence	*	*	*	*			
drop synonym	*	*	*	*			
drop user	*	*	*	*			
drop view	*	*		*			
each row	*		*				
each statement	*		*				
enable security_audit	*	*	*	*			
end exclude	*		*				
end transaction		*	*	*	*	*	*
exec sql	*		*				
execute immediate	*			*			
execute on	*			*			
execute procedure	*			*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
foreign key	*	*		*			
for deferred		*			*		
for direct		*			*		
for readonly		*			*		
for retrieve	*				*		
for update					*		
from group		*		*			
from role		*		*			
from user		*		*			
full join	*	*		*			
full outer	*	*		*			
get attribute	*		*				
get data	*		*				
get dbevent	*		*	*			
get global	*		*				
global temporary	*			*			
help all	*		*				
help comment	*		*				
help integrity			*			*	
help permit			*			*	
help table	*		*				
help view			*			*	
identified by	*			*			
inner join	*	*		*			
is null					*		
isolation level	*		*		*		
left join	*	*		*			
left outer	*	*		*			
modify table	*			*			

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
next value	*	*	*	*			
no cache	*	*	*	*			
no cycle	*	*	*	*			
no maxvalue	*	*	*	*			
no minvalue	*	*	*	*			
no order	*	*		*			
not like	*	*		*			*
not null	*				*		
on commit	*	*	*	*			
on current	*	*					
on database		*		*			
on dbevent		*		*			*
on location	*	*		*			
on procedure	*	*					
on sequence	*	*					
only where					*		
open cursor			*		*	*	
order by					*		
primary key	*	*		*			
procedure returning	*			*			*
put data	*		*				
raise dbevent		*	*	*			
raise error		*					
read only	*		*				
read write	*		*				
register dbevent		*	*	*			
register table	*						*
register view	*			*			*

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
remote system_password	*		*				
remote system_user	*		*				
remove dbevent		*	*	*			
remove table	*						*
remove view	*			*			*
replace cursor			*		*	*	*
result row	*	*	*	*			
resume entry	*			*			*
resume menu	*			*			*
resume next	*			*			*
resume nextfield	*			*			*
resume previousfield	*			*			*
retrieve cursor			*		*	*	
right join	*	*		*			
right outer	*	*		*			
run submenu	*			*			*
send userevent	*			*			
session group	*			*			
session role	*			*			
session user	*			*			
set aggregate	*	*			*		
set attribute	*		*				
set autocommit	*	*			*		
set connection	*		*	*			*
set cpufactor	*	*			*		
set date_format	*	*			*		
set ddl_concurrency	*	*					
set decimal	*	*			*		

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
set flatten	*	*			*		
set global	*		*				
set hash	*	*			*		
set io_trace	*	*			*		
set jcpu factor	*				*		
set joinop	*	*			*		
set journaling	*	*			*		
set lock_trace	*	*			*		
set lockmode	*	*			*		
set log_trace	*	*			*		
set logdbevents	*	*					
set logging	*	*			*		
set maxconnect	*	*			*		
set maxcost	*	*			*		
set maxcpu	*	*			*		
set maxidle		*			*		
set maxio		*			*		
set maxpage	*	*			*		
set maxquery	*	*			*		
set maxrow		*			*		
set money_format	*	*			*		
set money_prec	*	*			*		
set noflatten	*	*			*		
set nohash	*	*					
set noio_trace	*	*			*		
set nojoinop	*	*			*		
set nojournaling	*	*			*		
set nolock_trace	*	*			*		
set nolog_trace	*	*			*		

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
set nologdbevents	*	*					
set nologging	*	*			*		
set nomaxconnect	*	*			*		
set nomaxcost	*	*			*		
set nomaxcpu	*	*			*		
set nomaxidle	*	*			*		
set nomaxio	*	*			*		
set nomaxpage	*	*			*		
set nomaxquery	*	*			*		
set nomaxrow	*	*			*		
set noojflatten	*	*					
set nooptimizeonly	*	*			*		
set noparallel	*	*					
set noprintdbevents	*	*					
set noprintqry	*	*			*		
set noprintrules	*	*					
set noqep	*	*			*		
set norowlabel_visible	*	*					
set norules	*	*					
set nosql	*				*		
set nostatistics	*	*			*		
set notrace	*	*			*		
set nunicode_substitutio n	*	*					
set ojflatten	*	*					
set optimizeonly	*	*			*		
set parallel	*	*					
set printdbevents	*	*					

Keyword	Non 6.4	SQL			QUEL		
		ISQL	ESQL	4GL	IQUE L	EQUEL	4GL
set printqry	*	*			*		
set printrules	*	*					
set qep	*	*			*		
set random_seed	*	*			*		
set result_structure	*	*			*		
set ret_into	*	*			*		
set role	*	*					
set rowlabel_visible	*	*					
set rules		*					
set session	*	*			*		
set sql	*				*		
set statistics	*	*			*		
set trace	*	*			*		
set transaction	*	*					
set unicode_substitution	*	*					
set update_rowcount	*	*			*		
set work	*	*					
system user	*			*			
to group		*		*			
to role		*		*			
to user		*	*	*			
user authorization	*			*			
with null					*		
with short_remark	*	*					

Other Reserved Keywords

The following reserved keywords are only in the context of a WITH PARTITION= clause.

automatic	partition
hash	range
list	to
null	values
on	with

Appendix C: Features Introduced in Ingres 2.6

This appendix describes the new features of Ingres 2.6, including the following:

- User-visible language enhancements
- Increased maximum size of character data types
- User-visible DBA enhancements
- Internal performance enhancements
- Locking system performance improvements
- Logging system performance improvements
- Buffer manager performance improvements
- Operating system integration
- Ingres ICE enhancements
- ODBC enhancements
- JDBC enhancements
- Support for Unicode
- New character sets to support Euro currency symbol

User-Visible Language Enhancements

Enhancements have been made to the internal performance that concern row producing procedures.

Row Producing Procedures

This enhancement to the Ingres database procedure language addresses the ability of Ingres to read and return to the caller multiple rows from a select statement.

With server-executed database procedures, the program logic of the procedure is executed entirely in the server address space. Multiple SQL DML requests are executed in a single invocation of the procedure, with only one interaction with the client application. The ability to process and return multiple “rows” of some composite data types with a single call to a server-resident database procedure adds to the potential for improved performance of an application.

In a typical computing environment with applications executing on a variety of computers throughout a network, this approach can significantly reduce the footprint of the client application and the traffic across the network.

SUBSTRING Function

The ANSI compliant SUBSTRING function has been added to the SQL syntax. The SUBSTRING function is often easier to use than combinations of LEFT and SHIFT functions that Ingres traditionally supported. The syntax is:

substring(string-expr from start-column for length)

and the **for length** clause is optional.

New Aggregate Functions

Additional aggregate functions for statistical analysis have been added:

- The function **corr** computes a correlation coefficient
- Functions **covar_samp** and **covar_pop** compute covariance
- A collection of **regr_xx** functions generate regression analysis results

For details, see the *SQL Reference Guide*.

Increased Maximum Size of Character Data Types

Prior to Ingres 2.6, character data types were limited to a maximum size of 2000 bytes; this restriction was imposed when the maximum size of a row was limited to 2 KB. This limit is increased to 32000 bytes, the maximum row size supported in Ingres 2.6.

User-Visible DBA Enhancements

Enhancements have been made to internal performance that concern auditdb utility, copydb utility, raw location support, and GatherWrite threads.

Usermod Utility

Ingres now includes a usermod utility that allows users to run the modify commands on user tables. Like sysmod, which modifies system catalogs, this utility is useful for maintaining user tables on a regular basis.

Running this utility regularly, or when the table has excess overflow pages, improves performance of user applications.

Auditdb Utility

Various enhancements to the auditdb utility required by Journal Analyzer are included:

- Specification of fully qualified table names.
- Correct formatting of the output for -aborted_transaction when used with -b and -e flags.
- Corrected -aborted_transaction flag, allowing auditdb to write correct format for BT and ET records.
- Savepoint information in the auditdb output. This is achieved by printing out the abortsave record, which contains the LSN of the aborted savepoint.
- The order of output for lsn low/high fields for the ASCII output of auditdb, allowing the high lsn to be printed before low LSN.
- Two new auditdb options: -start_lsn=<LSN> -end_lsn=<LSN> for non -all cases.

For the syntax of the auditdb command, see the *Command Reference Guide*.

Copydb Utility

The copydb utility is modified to include several options and flags that modify the copy.in and copy.out scripts based on user requirements. The user can specify the order in which the copy and modify statements are written to the copy.in script, for example, whether to copy the data into the tables and then run a modify statement or the other way around. Other examples include the ability to remove hard-coded paths to the copy scripts, exclusion of location names, and exclusion of user-specific permissions such as grant statements.

Raw Location Support

Ingres 2.6 adds initial support for raw data locations on UNIX platforms. Raw data locations provide dramatic performance improvements over cooked locations. In this release, only one table may occupy any given raw location. Many raw locations can exist on a single raw disk slice.

GatherWrite Threads

A new internal thread type, GatherWrite, is used by the Ingres buffer manager during operations that require the flushing of multiple buffers from the cache such as write behind, consistency points, and table purges. This feature is only available on platforms that offer `writev()` support. Consult the appropriate Readme file to determine whether this feature is supported on your platform.

This feature is enabled on a per-server basis using the `gather_write` parameter in Configuration-By-Forms. The default setting is ON.

XML Import/Export Utility

XML is as a cross-platform, software- and hardware-independent tool for transmitting information. The XML import/export utility imports and exports XML data from Ingres tables to and from XML files. For the syntax of the XML import/export utility, `xmlimport`, see the *Command Reference Guide*.

Journal Analyzer

The Journal Analyzer is a powerful graphical tool that provides an interface to the journal files. You can use the Journal Analyzer to recover data from the journals and to apply journaled transactions to other databases, both local and remote. For information on the Journal Analyzer utility, see the *System Administrator Guide*.

Import Assistant

The Import Assistant is a wizard that simplifies the task of importing data from a standard file format to an Ingres database. For information on the Import Assistant utility, see the online help.

Automated Creation of Location Directories

Before Version 2.6, the Ingres DBA had to manually create the directories for alternate locations as prescribed in the *Database Administrator Guide*. This step had to be performed prior to creating a Location with ACCESSDB, or could be deferred if Locations were created using EXEC SQL CREATE LOCATION syntax. To circumvent directory permissions problems, ACCESSDB had to be run by the Ingres user whenever Locations were created, altered, or extended.

This process is clarified and simplified in Ingres 2.6 with the following changes:

- The Ingres server performs all manipulations of Location directories. This resolves the permissions problems of earlier releases and allows any ACCESSDB user with the "maintain_locations" privilege to create, alter, or extend Locations.
- The server automatically creates Location directories when a CREATE/ALTER LOCATION statement is executed, whether by ACCESSDB or user-invoked SQL. Because only missing directories are created, the DBA retains the ability to manually create as much, or all, of the Location path as wanted before creating the Location.

Using the example from the section Create an Area in UNIX in the *Database Administrator Guide*, the following directories will be verified or created automatically during the execution of:

```
CREATE LOCATION new_loc WITH AREA='/otherplace/new_area', USAGE=(DATABASE)
```

Perms	Directory
	/otherplace
755	/otherplace/new_area
755	/otherplace/new_area/ingres
700	/otherplace/new_area/ingres/data
777	/otherplace/new_area/ingres/data/default

Notes:

- Permissions are *not* changed for extant directories.
- The top-level directory "/otherplace" must exist and will *not* be created by the server.
- Raw location directories (UNIX only) cannot be automatically created and must be made with the MKRAWAREA utility, which must be run by "root." The Locations may be created prior to MKRAWAREA but a warning will be issued noting that the utility must be run prior to their use.

Remote Command Server Enhancements

Users commonly encounter problems running utilities that require exclusive access to the iidbdb database because the Remote Command Server process (rmcmd) keeps a session open on this database. To counter this problem, rmcmd now attaches to imadb instead of iidbdb; imadb is a system database that contains no historical data; it is rarely backed up and requires little or no maintenance.

Microsoft Transaction Server Support

Support for tightly coupled XA threads and shared lock lists is now available to support Microsoft Transaction Server, using the ODBC 3.5 driver.

Concurrent Rollback

The concurrent recovery of multiple transactions is now possible.

Internal Performance Enhancements

Enhancements have been made to the internal performance that concern aggregate sort nodes, composite histograms, and optimizer support for hash joins.

Aggregate Sort Nodes

Improvements to aggregate handling allows Ingres to better support data-mining products such as CleverPath OLAP, which make extensive use of data aggregation.

Previous versions required a sort before doing grouping and aggregation. Ingres 2.6 now does grouping with hash bucketing instead of sorting. Hash grouping is usually faster than sorting. Other internal refinements streamline the calculation of common aggregates, reducing the amount of CPU time needed.

Composite Histograms

The composite histograms enhancement allows the creation of composite or multi-column histograms that model much more accurately the dependence of the values of one column on another, and lead to far better selectivity estimates and, ultimately, to better query plans.

Optimizer Support for Hash Joins

Hash joins have been implemented in Ingres 2.6. A hash join is one in which a hash table is built with the rows of one of the join sources by hashing on the key columns of the join. The rows of the other join source are then read and hashed into the table on their key columns. The hashing of the second set of rows quickly identifies pairs of joining rows. This technique requires no index structures on the join columns (as does KEY join), nor does it require sorting on the join columns (as does merge join).

Locking System Performance Improvements

A number of improvements have been made to the locking system to eliminate or minimize bottlenecks identified when running various performances tests.

Preallocated RSB/LKBs

Each resource RSB now has an embedded a lock block (LKB), removing the need for a separate, contentious LKB allocation every time a new resource is allocated.

An LLB stash of LKBs is also maintained, similar to the RSB stash.

When an RSB or LKB is freed, it is returned to the LLB's stash; when the lock list itself is freed, all stashed RSB/LKBs are returned to the free pool.

Miscellaneous Locking System Improvements

The following miscellaneous locking system improvements are included in Ingres 2.6:

- The number of RSB waiters and converters are now maintained in the RSB.
- The deadlock wait-for graph lock (lkd_dlock_lock) does not need to be held if the RSB has neither waiters nor converters.
- The LKREQ built in the stack does not need to be copied to the LKB indiscriminately.
- When a lock request is blocked, the blocker's identity is now saved in the LKREQ and formatted in SYS_ERR only when the request fails.

Logging System Performance Improvements

A number of improvements to the logging system eliminate or at least minimize bottlenecks identified when running various performance tests. These changes include elimination of contentious `current_llb_mutex`, faster log forces through forcing only what needs forcing, and improved concurrency potential (fast resume).

Buffer Manager Performance Improvements

A number of improvements have been made to the buffer manager to eliminate or minimize bottlenecks identified when running various performance tests. These include:

- Removal of stats for fixed priority pages. In Ingres 2.6, stats are tracked by buffer page type for better analysis of the BM's LRU algorithm.
- Raising a buffer's priority each time it is fixed; previously it was raised only when newly fixed.

Operating System Integration

Enhancements have been made to the internal performance that concern 64-bit operating systems and operating system thread implementation on Linux.

64-Bit Operating Systems

Now that Microsoft, Sun, HP, and Linux vendors have produced 64-bit versions of their operating systems, we are providing a 64-bit build of Ingres on these platforms. Every effort is made to exploit large memory and files in these 64-bit environments.

Operating System Thread Implementation on Linux

Ingres 2.6 provides support for operating system threads in Linux environments including Intel, Alpha, S/390, and IA64. Operating system threads perform better in most circumstances than the internal Ingres threading model.

Ingres ICE Enhancements

Ingres/ICE development environment and setup and configuration are addressed in Ingres 2.6 through integration with an existing Web application development environment.

ICE Development Environment

The ICE macro DTD can be used with an XML-aware editor to provide a development environment for Ingres/ICE application development. A converter has been added to take new macro syntax into the old macro syntax during page registration.

ODBC Enhancements

The ODBC driver has been updated to Version 3.5.

Functions Supported by ODBC Driver

The Ingres ODBC driver supports all level one functions, as well as the following level two functions:

- SQLExtendedFetch (through Microsoft Cursor Library only)
- SQLForeignKeys
- SQLMoreResults
- SQLNumParam
- SQLPrimaryKeys
- SQLProcedureColumns
- SQLProcedures
- SQLSetPos (through Microsoft Cursor Library only)

Unavailable Features in the ODBC Driver

The Ingres ODBC driver does not provide the following features as of Release 2.6:

- Executing functions asynchronously
- Translation DLL
- Support for Ingres SQL COPY TABLE command
- Support for Ingres SQL SAVEPOINT command

JDBC Enhancements

The following JDBC 2.0 extensions have been added to Ingres:

- Compatibility with GA release (protocol levels)
- Execution in JDK 1.1 environment due to a new driver
- Batch processing
- javax—two-phase commit
- javax—client connection pooling
- Updateable result sets

The following are new features:

- Support for Ingres intervals
- Coalescing statement IDs
- Utilization of VNODE passwords
- Local connections without passwords
- Support for procedure table parameters
- Support for row producing procedure

Support for Unicode

This release contains the first phase of Ingres support for Unicode; further Unicode support will be added in future releases.

In this release, the DBMS supports three new data types:

- `nchar`
- `nvarchar`
- `long nvarchar`

These data types store character data using two bytes for each character. Collation of these data types uses the standard collation algorithm as defined by the Unicode organization, and the data types can be used in indexes and database statistics.

The native two-byte (UCS2) format is supported and maintained through the entire process, from the front-end application, through the DBMS, to the data representation on disk.

The embedded SQL preprocessor for C and C++ supports declaration of `wchar_t` variables, which are assumed to contain multi-byte Unicode character strings.

OpenAPI version 3 was added to indicate support for these new data types.

VDBA also supports the new data types.

Support for the ODBC and JDBC drivers is present through their normal Unicode interfaces.

These new data types are not supported in any of the character-based tools or any of the terminal monitors.

This release does not support coercion between Unicode data types and non-Unicode data types such as `char` and `varchar`.

New Character Sets to Support Euro Currency Symbol

Two new character sets that contain the Euro currency sign (€, Unicode U+20AC) are added: IS885915 and WIN1252.

To set the money format to the Euro currency symbol you must issue the following command:

```
ingsetenv II_MONEY_FORMAT L:€
```

Alternatively, you can set this value in the Ingres Visual Manager (IVM).

Windows:

WIN1252 corresponds to Windows code page 1252 Latin 1. This is the common character set of most American and Western European Windows PCs, and includes the Euro sign. Users wishing to use the Euro symbol in a Windows GUI environment need to select the WIN1252 character set at installation time. To set this code page in a Windows command prompt environment, you must issue the following Windows command:

```
chcp 1252
```

The default font in a Windows command prompt does not provide support for the Euro currency symbol. For a workaround, set the font to Lucida Console. The Lucida Console font has moved the line drawing characters, used in Ingres forms, into an area not accessible to Ingres binaries, so we have provided rudimentary line drawing in the IBMPCD terminal entry. To set this terminal type, you must either issue the following command:

```
ingsetenv TERM_INGRES IBMPCD
```

or set TERM_INGRES through IVM or specify this terminal type at install time.




UNIX:

IS885915 corresponds to the ISO 8859-15 Latin 9-character set that is almost identical to the ISO 8859-1 Latin 1 set, except for eight characters; chief among them is the Euro currency sign (€, Unicode U+20AC).

If you have an existing installation and would like to change the character set, be aware that this is not typically supported because the new character set could display existing characters in your databases incorrectly. However, since the ISO 8859-15 only has eight characters that are different from ISO 8859-1, if you can verify that none of the eight characters are already present in your databases, you could safely change the set (by changing II_CHARSETxx).

The following table details these differences and provides the corresponding Unicode character names:

Hex		ISO 8859-1		ISO 8859-15
A4	■	Currency symbol	€	Euro sign
A6	¡	Broken bar	Š	Latin capital letter with caron
A8	¨	Diaeresis	š	Latin small letter with caron
B4	’	Acute accent	Ž	Latin capital letter Z with caron
B8	¸	Cedilla	ž	Latin small letter Z with caron
BC	¼	Vulgar fraction one quarter	Œ	Latin capital ligature OE
BD	½	Vulgar fraction one half	œ	Latin small ligature oe
BE	¾	Vulgar fraction three quarters	Ÿ	Latin capital letter Y with diaeresis

Differences Between ISO 8859-1 and ISO 8859-15 Character Sets 

Appendix D: Features Introduced in Ingres II 2.5

This appendix describes the features and enhancements introduced in Ingres II 2.5, including:

- Sort enhancements
- ANSI/ISO constraint enhancements
- Large cache support
- Dynamic Write Behind threads
- Partitioned transaction log file
- Optimizedb enhancements
- Read-only database support
- New SQL functionality
- Extended date support
- Large file support
- Large catalogs
- Row locking for system catalogs
- Update mode locking
- Query optimization enhancements
- Ingres Star features
- Ingres Net features
- Ingres ICE features
- Visual DBA features
- Replicator enhancements
- OpenAPI enhancements

Sort Enhancements

Changes were made to improve the performance of both the in-memory (QEF) sort and disk (DMF) sort of Ingres II.

QEF Sort Enhancements

QEF was improved by fine-tuning the sort algorithm, resulting in fewer comparisons between sort rows. The sort algorithm is a major consumer of CPU time in a sort. QEF was also improved with a change that results in the rows being partially sorted as they arrive in the sort.

This change introduces two distinct benefits:

- Duplicate rows are detected and discarded more quickly from duplicate removal sorts (as required by "select distinct..."). This in turn increases the number of rows that can be processed in memory for a duplicates removal sort, avoiding more expensive disk sorts in many instances.
- The first rows in the sort sequence can be returned before the remaining rows are completely sorted. Tests show that the first sorted row is available with as few as 20% of the overall comparisons required to complete the sort. This means that browsing or scrolling applications see the first set of rows in less time than before.

DMF Sort Enhancements

The first set of DMF sort enhancements also involve fine-tuning of the sort algorithms, which should result in a 5 to 10 percent reduction in CPU time of typical sorts. As with the QEF sort, duplicate rows are detected and discarded sooner in duplicates removal sorts. This should result in smaller disk work files and faster overall sort performance.

Prior to Release 2.5, the entire result of a DMF sort was spooled to an internal temporary table before the sorted rows were returned to the caller. In Ingres II 2.5, the temporary table has been eliminated and the rows are returned directly from the sort structures to the caller. This has the same effect as the early return of sorted rows described above for the QEF sort. That is, the first rows should be returned much sooner than they were in previous releases.

The final DMF sort enhancement is the introduction of a “parallel sort” technique. Sorts that exceed a user-configurable threshold spawn additional threads. The sort is split up and its rows delivered to the sub-threads for sorting. The sorted subsets of the rows are then delivered back to the parent thread executing the query, where they are merged to form a single sorted stream of rows.

On multi-CPU machines, this results in a significant reduction in the elapsed time required to sort (between 25 to 50 percent in testing). Even single CPU machines benefit somewhat, because sort I/O and sort computation can be overlapped. An added benefit to the parallel sort technique is that it is encapsulated within the DMF sort. This sort is used for the execution of queries with sorting requirements (such as for order by, group by, and distinct requests, or for implementing certain join algorithms). However, it is also used to sort rows for index creation or update in modify, create index, and copy operations. All users of the DMF sort derive the performance benefit of the parallel sort.

Parallel Sort Techniques

The “parallel sort” technique outlined in DMF Sort Enhancements (see page 147) is used to sort rows for parallel index creation, greatly reducing the time taken for index creation in multi-CPU environments.

ANSI/ISO Constraint Enhancements

Ingres referential and unique/primary key constraints result in the creation of indexes “under-the-covers” to improve the performance of the constraint enforcement mechanisms. Prior to Release 2.5, these indexes were plain B-tree indexes stored in the default location of the database. However, B-tree is not always the best choice (for example, hash is better for many unique key applications), and use of the default location can degrade performance if many large indexes are created.

Ingres II 2.5 solves these and other problems by including a “with” clause for constraint definition. The “with” clause allows the overriding of default index options with anything normally coded in an index creation “with” clause. For example, the index structure and location, as well as fillfactor and other index options can be explicitly specified for each constraint. The “with” clause applies to column and table constraints defined with both the create and alter table statements. A unique/primary key constraint can be generated to use the base table structure for its enforcement rather than a separate secondary index.

Ingres II 2.5 also introduces the ANSI/ISO notion of referential actions for the definition of referential (foreign key) constraints. In releases prior to Ingres II 2.5, the attempt to delete a referenced row for which matching referencing rows exist, or to update the primary key of a referenced row to some other value while matching referencing rows still exist for the old value, was met with an error and the request was aborted. Either operation had to be preceded by a delete of the matching referencing rows or an update of the foreign keys to some value that exists in another referenced row.

Ingres II 2.5 allows the definition of referential actions for each referential constraint, which defines alternative actions to be taken in the circumstances defined above. A separate action can be defined for both the delete case (deletion of a referenced row with matching referencing rows) and the update case (updating the key of a referenced row with matching referencing rows). The options include *cascade*, in which case the delete or update is cascaded to the matching referencing rows (so that the referencing rows are also deleted or updated to the same value), and *set null*, in which case the foreign key of the matching referencing rows is set to null. These actions permit a more complete definition of the semantics of the referential relationship and allow the application to execute more efficiently.

Large Cache Support

In Ingres II 2.5, the total number of pages in all caches has been revised from an un-enforced limit of 65536 to $2^{32}-1$. Ingres II 2.5 supports a 4 GB cache.

In previous releases, when those pages belonging to a specific table needed to be located, the buffer manager sequentially searched every buffer in every cache to find them. Even in installations with small caches, this was an expensive operation, especially in those frequent instances in which there were no table-pages in any cache. This operation occurred, for example, when a table's TCB was about to be released, typically when all referencing transactions had no immediate need to use the table. Delays caused by this operation could show up in unexpected situations, such as the use of statement level rules.

In Ingres II 2.5, a cross-cache table hash queue has been added to the buffer manager to which pages are added as they are faulted in and removed when they are tossed. Thus, when the need to know a table's pages arises, a hash on the table's database ID and table ID is made and that list searched for matching pages. This change results in a significant decrease in the number of cache pages visited and is most dramatic in installations configured with very large or multiple caches.

Dynamic Write Behind Threads

In releases prior to Ingres II 2.5, a fixed number of Write Behind threads were configured in each server in an installation and initiated when the server started. These threads served all caches and were awakened when the number of modified pages in any cache exceeded a predefined threshold. In a shared cache environment, all Write Behind threads in all servers were simultaneously activated when this threshold was reached. This led to a “thundering herd” phenomenon in which n Write Behind threads concurrently pounded through the caches, competing for modified pages to flush.

The optimum number of Write Behind threads is the minimum number required to:

- Maintain the modified buffer count below the Write Behind start threshold
- Supply sufficient free pages to avoid synchronous writes.

The optimum number of Write Behind threads varies with the instantaneous demand for free pages in a particular cache; it always begins at one when the threshold is first breached and a Write Behind event signaled. In Ingres II 2.5, if the single Write Behind thread is unable to keep up with the demand, additional Write Behind threads are created until either equilibrium is achieved or the upper limit on thread numbers is reached. If better than equilibrium is achieved (more modified pages are being freed than are in demand), the excess Write Behind threads terminate one-by-one, while the remaining threads continue to monitor the free buffer demand to achieve the write-behind end threshold.

Ingres II 2.5 introduces cache-specific Write Behind threads, resulting in increased concurrency and eliminating the chance of free page starvation.

Partitioned Transaction Log File

The structure of the log file in Ingres II 2.5 is changed from a single file to 1-16 logically striped files of equal size. Properly configured, partitioning in this manner encourages better log performance by spreading disk contention across multiple disks instead of concentrating it on a single device. Ingres system administration is made simpler, as the transaction log file can be expanded by adding another partition, instead of resizing an existing file or partition. The full log file paths are now defined through Configuration Manager or CBF rather than through the symbol table.

Optimizer and Optimizedb Enhancements

A variety of enhancements have been made to optimizedb.

The flag `-zlr` causes optimizedb to retain the original repetition factor when rebuilding an existing histogram. This is useful when a histogram (and its repetition factor) is built once by reading the whole table, then updated later using sampling (which can produce inaccurate repetition factors).

A minor bug was fixed to allow the `"l"` flag to request an exclusive lock on the database during optimizedb processing (just as for other command line utilities).

The current limit of 1000 parameters coded in a separate file using the `-zf` parameter has been lifted. There is now no limit to the number of such parameters.

An `-o` filename option (similar to that in `statdump`) has been added to optimizedb. It creates a `statdump`-style output file, which can then be input back to optimizedb with the `-i` filename option. But more importantly, it does not update the catalog `iistatistics` and `iihistogram` tables. This allows a busy shop to construct histograms at anytime, with no worry about update conflicts. Then at a convenient later time, optimizedb can be run with the `-i` option to add the histograms to the catalog.

In addition to the flag enhancements, an enhancement has been introduced to allow more accurate histograms to be built on columns with significant skew in their value sets. Specifically, a column with many distinct values, which would generate an inexact histogram, now produces exact cells for values that occur significantly more than the average. This permits much more accurate estimates in the compilation of queries with restrictions on such columns, and, therefore, better query plans.

The query compiler has been enhanced to compile more efficient strategies for complex queries involving aggregate views and unions.

Read-only Database Support

Ingres II 2.5 provides the ability to distribute a read-only database on a CD-ROM or other read-only media.

Example: Create a Read-only Database

For example, to create a read-only database called mydatabase on UNIX:

1. Log in as the installation owner.

2. Change location to the staging directory:

```
cd /stagingarea
```

3. Create directory and subdirectories:

```
mkdir ingres
```

```
mkdir ingres/data
```

```
mkdir ingres/data/default
```

4. Place appropriate permissions:

```
chmod 755 ingres
```

```
chmod 700 ingres/data
```

```
chmod 777 ingres/data/default
```

5. Change location to the database files:

```
cd /install/inst1/ingres/data/default
```

6. Copy the database directory and its subdirectories to the new area:

```
cp -r mydatabase /stagingarea/ingres/data/default/
```

7. Copy the directory structure to the CD-ROM or other device:

```
cp -r ingres/data/default/mydatabase /cdrom
```

Create a new database location using the create location statement or using the accessdb utility:

```
create location cdromloc with area=/cdrom, usage=(database);
```

8. Use the createdb command to access the read-only database in the installation:

```
createdb -r cdromloc mydatabase
```

New SQL Functionality

New SQL operations have been added, bringing Ingres SQL closer to the SQL standards. Enhancements have been made to the internal performance that concern bit-wise operator support and miscellaneous functions.

Order By/Group By Expression

The ORDER BY and GROUP BY statements now allow an expression instead of being limited to column names. ORDER BY can also reference a column name or expression that is not part of the select result list.

CASE Expression

An ANSI SQL '92 compliant CASE expression has been added. The CASE expression allows if-then-else testing anywhere that an expression is allowed.

There are two syntax forms. The most general CASE expression is:

```
case when boolean-expression then expression  
      when boolean-expression then expression  
      ...  
      else otherwise-expression  
end
```

Each *boolean-expression* is evaluated in turn, and if TRUE, the corresponding **then** expression is the CASE result. If all the *boolean-expressions* are of the form *expr1 = expr2*, a shorthand form can be used:

```
case expr1 when expr2 then expression  
      when expr3 then expression  
      ...  
      else otherwise-expression  
end
```

Parallel Index Creation

A new variation of the CREATE INDEX statement allows the user to create multiple secondary indexes with a single pass through the base table. After the required base table columns are extracted, the indexes are created in parallel, each one using an independent worker thread. For additional performance, any necessary sorting is performed using the new parallel sort capability.

The new syntax is:

```
create index (index-spec), (index-spec), ...
```

where an **index-spec** looks similar to the original CREATE INDEX statement:

```
(index-name on base-table (column-list) with with-clause)
```

SELECT Enhancement

The SELECT statement now allows the **first n** clause in the result list. This clause limits the result returned to the user to the first N rows.

Bit-wise Operator Support

The following functions have been added to Ingres II 2.5 to provide support for bit-wise operations:

bit_add

Logical "add" of two byte operands

bit_and

Logical "and" of two byte operands

bit_not

Logical "not" of two byte operands

bit_or

Logical "or" of two byte operands

bit_xor

Logical "exclusive or" of two byte operands

For all of these bit functions, all operations proceed right to left. The shorter of two operands is padded with hex zeroes on the left. The result is a byte field equal in size to the longer operand.

Aggregate Functions

New aggregate functions have been added:

- stddev_samp
- stddev_pop
- var_samp
- var_pop

The _pop forms divide by group size, the _samp forms divide by group size minus one.

Miscellaneous Functions

The following miscellaneous functions have been added to Ingres II 2.5:

intextract

Extracts the number at the given location.

ii_ipaddr

Converts an IP address to a byte 4.

random, randomf

Generates random integer or float8 values

power, ln

Are ANSI compliant synonyms for ** and log functions.

Several synonyms have been added to existing Ingres data types (such as character long object and clob for long varchar and binary long object and blob for long byte).

Extended Date Support

Ingres II 2.5 allows users to insert dates in the range 01-Jan-0001 to 31-Dec-9999.

Large File Support

A major enhancement to Ingres II 2.5 on operating systems that support 64-bit file systems is the ability to support file sizes greater than 2 GB. This means that larger table, dump, work, journal, and checkpoint files can be accommodated in a single location. It also removes the 2 GB limit on the size of the transaction log file.

Large Catalogs

In this release, system catalogs can use pages larger than 2 KB. As a result, the user does not have to configure a 2 KB cache size in the DBMS for system catalogs.

Row Locking for System Catalogs

For improved concurrency, the Ingres II 2.5 DBMS automatically uses row locking on system catalogs when catalogs are created using pages larger than 2 KB. This feature is keyed from the system default page size, which is configurable through Configuration-By-Forms or Configuration Manager. Createdb creates a database with system catalogs that have the default page size. Running sysmod on an existing database, however, does not automatically convert the system catalogs to use the default page size. The user must use the "with page_size" keyword to achieve this.

Update Mode Locking

Prior to Ingres II 2.5, when the DBMS fetched a row for a cursor mode update, it would acquire an exclusive lock. In serializable mode, this lock would be held until the end of transaction, even when the row was not updated. In this release, the Ingres DBMS acquires an update mode lock for the row that is a candidate for update. If the row is actually updated, the update mode lock is converted to logical exclusive lock; otherwise, it is converted down to shared lock or released, depending on the current isolation level. Update mode locking is now the default for cursor updates.

Value Locking for Serializable Transaction with Equal Predicate

Prior to Ingres II 2.5, the Ingres DBMS would hold a page lock on the leaf pages on B-tree tables for a serializable update transaction, even when using row locking. This was done to prevent other users from inserting a row in the qualified range to be updated. In Ingres II 2.5, the DBMS uses a value locking protocol for serializable transactions with an equal predicate, thereby allowing better concurrency.

Query Optimization and Execution Enhancements

Ingres II 2.5 incorporates a variety of internal enhancements to the compilation and execution of queries.

Ingres Star Features

In Ingres II 2.5 the Ingres Star Server now contains support for the 1Pcplus commit protocol, which allows a single site that is not capable of supporting two-phase commit protocols to participate in a multi-site update within Star. This change allows a single database that is being accessed through an Ingres Enterprise Access gateway that does not support the SQL prepare statement to participate in a multi-site Star update.

Ingres Net Features

GCF has responsibility for authenticating and validating clients for Ingres servers. Previously, security was built around operating system capabilities. The following improvements have been made to Ingres security for Ingres II 2.5:

- Support for third-party security systems such as Kerberos
- Enhancements for data encryption and direct network server connections
- Improved existing security by addressing known problems
- Backward compatibility for existing applications

Support for third-party security systems requires dynamic configuration capabilities since these systems are not a requirement for installation. In a design emulating the emerging standard GSS-API, the Ingres II 2.5 GCF security architecture is built around independent modules called *mechanisms*. Standard default mechanisms are provided for basic Ingres security and backward compatibility. Third-party security systems are supported through additional mechanisms, which are dynamically loaded as needed.

GCF security mechanisms provide the following capabilities:

- User authentication and validation
- Password validation
- Trusted server authentication and validation
- Distributed (single sign-on) authentication and validation
- Data encryption

Management of GCF security has been enhanced with new configuration parameters viewable through CBF and the Configuration Manager. Ingres II 2.5 also sees the addition of attributes to the Ingres/Net VNODE database, and new IMA objects (many of which can be set at runtime) for enhanced IMA support.

Ingres ICE Features

New features added to the internal performance of Ingres/ICE concern security, session management, storage management, and macro language extensions.

Ingres ICE Security Enhancements

The security model for Ingres/ICE has been enhanced to provide additional levels of control for access and for content. The model also assists in the maintenance of large numbers of Internet users by defining profiles and roles.

Profiles enable Internet users to register themselves by automatically transferring a predefined set of privileges to the user when the first login is attempted.

Password authentication for intranets may be specified as OS for use with domain servers and authentication servers.

Ingres ICE Session Management Enhancements

Ingres/ICE uses cookies to identify individual sessions. The session identifier enables maintenance of session context between pages. Sessions have a configurable inactivity timeout that when reached rolls back any uncommitted transactions.

Storage Management

HTML Templates--Document content is made available through HTML template files. In Ingres II 2.5, access to the template files is abstracted to prevent exposure of queries and schema.

Document Cache Management--All files accessed within Ingres/ICE are subject to cache management, which specifies when the file may be closed or removed.

Macro Language Extensions

Macro language extensions in Ingres II 2.5 include:

- User identification
- State maintenance
- Variables
- Conditional statements
- Variable testing using the IF or SWITCH macros to provide conditional flow within template pages
- Include statements
- The FUNCTION macro, providing a mechanism for invoking C callable shared libraries and dynamic link libraries

Visual DBA Features

Visual DBA features in Ingres II 2.5 include:

- DOM windows—new design and features
- SQL/test—new design and features
- Star management
- Full Replicator management
- ICE management
- Enterprise access
- Miscellaneous new features

Replicator Enhancements

Enhancements have been made to the internal performance that concern the generic Replicator Server and increased replicator concurrency.

Generic Replicator Server

Ingres II 2.5 introduces a generic Replicator Server that is functionally identical to the custom repserver built by the user in previous releases. The generic Replicator Server can automatically handle any table that is configured by RepManager or Visual DBA without the need to compile or link a custom executable.

Increased Replicator Concurrency

In previous releases, updates to the Replicator shadow, archive, and input queue tables performed by the DBMS as a result of a replicated user update would use the same isolation level as the original update (serializable by default). This isolation level is unnecessary, since the unique key value in the base table must have already been locked for the update to take place. In this release, the isolation level has been decreased to read committed, allowing for improved concurrency of replicated updates.

OpenAPI Enhancements

Environment handles were added to OpenAPI. Environment handles allow greater application control over configuration of the OpenAPI runtime environment. OpenAPI version 2 was added to indicate support for environment handles.

Extensions were made to the following OpenAPI functions to support environment handles:

- `IIapi_initialize()` to allocate environment handles
- `IIapi_connect()` to open connections using environment settings

Three new environment handle associated functions were added:

- `IIapi_setEnvParam()` for setting environment configuration parameters
- `IIapi_formatData()` for converting data values relative to environment settings
- `IIapi_releaseEnv()` to release environment handle resources

Also added is the function `IIapi_abort()` to forcefully shut down connections under error conditions.

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