Open Message Queue

Developer's Guide for Java Clients

Release 5.0

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This guide provides information about concepts and procedures for developing Java messaging applications (Java clients) that work with Message Queue.

Open Message Queue Developer's Guide for Java Clients, Release 5.0

Contents

Preface

This book provides information about concepts and procedures for developing Java messaging applications (Java clients) that work with Message Queue.

This preface consists of the following sections:

- Who Should Use This Book
- Before You Read This Book
- How This Book Is Organized
- Documentation Conventions
- Related Documentation
- Documentation, Support, and Training
- Documentation Accessibility

Who Should Use This Book

This guide is meant principally for developers of Java applications that use Message Queue.

These applications use the Java Message Service (JMS) Application Programming Interface (API), and possibly the SOAP with Attachments API for Java (SAAJ), to create, send, receive, and read messages. As such, these applications are JMS clients and/or SOAP client applications, respectively. The JMS and SAAJ specifications are open standards.

This book assumes that you are familiar with the JMS APIs and with JMS programming guidelines. Its purpose is to help you optimize your JMS client applications by making best use of the features and flexibility of a Message Queue messaging system.

This book assumes no familiarity, however, with SAAJ. This material is described in Chapter 6, "Working with SOAP Messages" and assumes only basic knowledge of XML.

Before You Read This Book

You must read the *Open Message Queue Technical Overview* to become familiar with the Message Queue implementation of the Java Message Specification, with the components of the Message Queue service, and with the basic process of developing, deploying, and administering a Message Queue application.

How This Book Is Organized

This guide is designed to be read from beginning to end. The following table briefly describes the contents of each chapter.

Chapter	Description
Chapter 1, "Overview"	A high-level overview of the Message Queue Java interface. It includes a tutorial that acquaints you with the Message Queue development environment using a simple example JMS client application.
Chapter 2, "Message Queue Clients: Design and Features"	Describes architectural and configuration issues that depend upon Message Queue's implementation of the Java Message Specification.
Chapter 3, "The JMS Simplified API"	Explains how to use the simplified API introduced by the Java Message Service (JMS) specification, Version 2.0, in your client application.
Chapter 4, "The JMS Classic API"	Explains how to use the Message Queue Java API in your client application.
Chapter 5, "Using the Metrics Monitoring API"	Describes message-based monitoring, a customized solution to metrics gathering that allows metrics data to be accessed programmatically and then to be processed in whatever way suits the consuming client.
Chapter 6, "Working with SOAP Messages"	Explains how you send and receive SOAP messages with and without Message Queue support.
Appendix A, "Warning Messages and Client Error Codes"	Provides reference information for warning messages and error codes returned by the Message Queue client runtime when it raises a JMS exception.

Documentation Conventions

This section describes the following conventions used in Message Queue documentation:

- Typographic Conventions
- Symbol Conventions
- Shell Prompt Conventions
- Directory Variable Conventions

Typographic Conventions

The following table describes the typographic conventions that are used in this book.

Typeface	Meaning	Example
`AaBbCc123`	The names of commands, files, and directories, and onscreen computer output	Edit your `.login` file. Use `ls a` to list all files. `machine_name% you have mail.`

`AaBbCc123`	What you type, contrasted with onscreen computer output	`machine_name%` **`su`**
		`Password:`

aabbcc123	Placeholder: replace with a real name or value	The command to remove a file is `rm` *filename*.
AaBbCc123	Book titles, new terms, and terms to be emphasized	Read Chapter 6 in the *User's Guide*. A *cache* is a copy that is stored locally. Do *not* save the file. **Note:** Some emphasized items appear bold online.

Symbol Conventions

The following table explains symbols that might be used in this book.

Symbol	Description	Example	Meaning
`[ ]`	Contains optional arguments and command options.	`ls [-l]`	The `-l` option is not required.
`{ | }`	Contains a set of choices for a required command option.	`-d {y|n}`	The `-d` option requires that you use either the `y` argument or the `n` argument.
`${ }`	Indicates a variable reference.	`${com.sun.javaRoot}`	References the value of the `com.sun.javaRoot` variable.
-	Joins simultaneous multiple keystrokes.	Control-A	Press the Control key while you press the A key.
+	Joins consecutive multiple keystrokes.	Ctrl+A+N	Press the Control key, release it, and then press the subsequent keys.
>	Indicates menu item selection in a graphical user interface.	File > New > Templates	From the File menu, choose New. From the New submenu, choose Templates.

Shell Prompt Conventions

The following table shows the conventions used in Message Queue documentation for the default UNIX system prompt and superuser prompt for the C shell, Bourne shell, Korn shell, and for the Windows operating system.

Shell	Prompt
C shell on UNIX, Linux, or AIX	*machine-name*`%`
C shell superuser on UNIX, Linux, or AIX	*machine-name*`#`
Bourne shell and Korn shell on UNIX, Linux, or AIX	`$`
Bourne shell and Korn shell superuser on UNIX, Linux, or AIX	`#`
Windows command line	`C:\>`

Directory Variable Conventions

Message Queue documentation makes use of three directory variables; two of which represent environment variables needed by Message Queue. (How you set the environment variables varies from platform to platform.)

The following table describes the directory variables that might be found in this book and how they are used. Some of these variables refer to the directory *mqInstallHome*, which is the directory where Message Queue is installed to when using the installer or unzipped to when using a zip-based distribution.

Note: In this book, directory variables are shown without platform-specific environment variable notation or syntax (such as `$IMQ_HOME` on UNIX). Non-platform-specific path names use UNIX directory separator (`/`) notation.

Variable	Description
`IMQ_HOME`	The Message Queue home directory: ■ For installations of Message Queue bundled with GlassFish Server, `IMQ_HOME` is *as-install-parent*`/mq`, where *as-install-parent* is the parent directory of the GlassFish Server base installation directory, `glassfish3` by default. ■ For installations of Open Message Queue, `IMQ_HOME` is *mqInstallHome*`/mq`.
`IMQ_VARHOME`	The directory in which Message Queue temporary or dynamically created configuration and data files are stored; `IMQ_VARHOME` can be explicitly set as an environment variable to point to any directory or will default as described below: ■ For installations of Message Queue bundled with GlassFish Server, `IMQ_VARHOME` defaults to *as-install-parent*`/glassfish/domains/domain1/imq`. ■ For installations of Open Message Queue, `IMQ_HOME` defaults to *mqInstallHome*`/var/mq`.
`IMQ_JAVAHOME`	An environment variable that points to the location of the Java runtime environment (JRE) required by Message Queue executable files. By default, Message Queue looks for and uses the latest JDK, but you can optionally set the value of `IMQ_JAVAHOME` to wherever the preferred JRE resides.

Related Documentation

The information resources listed in this section provide further information about Message Queue in addition to that contained in this manual. The section covers the following resources:

- Message Queue Documentation Set
- Java Message Service (JMS) Specification
- JavaDoc
- Example Client Applications
- Online Help

Message Queue Documentation Set

The documents that constitute the Message Queue documentation set are listed in the following table in the order in which you might normally use them. These documents are available through the Oracle GlassFish Server documentation web site at `http://www.oracle.com/technetwork/indexes/documentation/index.html`.

Document	Audience	Description
Technical Overview	Developers and administrators	Describes Message Queue concepts, features, and components.
Release Notes	Developers and administrators	Includes descriptions of new features, limitations, and known bugs, as well as technical notes.
Administration Guide	Administrators, also recommended for developers	Provides background and information needed to perform administration tasks using Message Queue administration tools.

Document	Audience	Description
Developer's Guide for Java Clients	Developers	Provides a quick-start tutorial and programming information for developers of Java client programs using the Message Queue implementation of the JMS or SOAP/JAXM APIs.
Developer's Guide for C Clients	Developers	Provides programming and reference documentation for developers of C client programs using the Message Queue C implementation of the JMS API (C-API).
Developer's Guide for JMX Clients	Administrators	Provides programming and reference documentation for developers of JMX client programs using the Message Queue JMX API.

Java Message Service (JMS) Specification

The Message Queue message service conforms to the Java Message Service (JMS) application programming interface, described in the *Java Message Service Specification.* This document can be found at the URL `http://www.oracle.com/technetwork/java/jms/index.html`.

JavaDoc

JMS and Message Queue API documentation in JavaDoc format is included in Message Queue installations at `IMQ_HOME/javadoc/index.html`. This documentation can be viewed in any HTML browser. It includes standard JMS API documentation as well as Message Queue-specific APIs.

Example Client Applications

Message Queue provides a number of example client applications to assist developers.

Example Java Client Applications

Example Java client applications are included in Message Queue installations at `IMQ_HOME/examples`. See the `README` files located in this directory and its subdirectories for descriptive information about the example applications.

Example C Client Programs

Example C client applications are included in Message Queue installations at `IMQ_HOME/examples/C`. See the `README` files located in this directory and its subdirectories for descriptive information about the example applications.

Example JMX Client Programs

Example Java Management Extensions (JMX) client applications are included in Message Queue installations at `IMQ_HOME/examples/jmx`. See the `README` files located in this directory and its subdirectories for descriptive information about the example applications.

Online Help

Online help is available for the Message Queue command line utilities; for details, see "Command Line Reference" in *Open Message Queue Administration Guide*. The Message Queue graphical user interface (GUI) administration tool, the Administration Console, also includes a context-sensitive help facility; for details, see "Administration Console Online Help" in *Open Message Queue Administration Guide*.

Documentation, Support, and Training

The Oracle web site provides information about the following additional resources:

- Documentation (`http://docs.oracle.com/`)
- Support (`http://www.oracle.com/us/support/044752.html`)
- Training (`http://education.oracle.com/pls/web_prod-plq-dad/db_pages.getpage?page_id=315`)

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at `http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc`.

Access to Oracle Support

Oracle customers have access to electronic support through My Oracle Support. For information, visit `http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info` or visit `http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs` if you are hearing impaired.

1 Overview

This chapter provides an overall introduction to Message Queue and a quick-start tutorial. It describes the procedures needed to create, compile, and run a simple example application. Before reading this chapter, you should be familiar with the concepts presented in the *Open Message Queue Technical Overview*.

The chapter covers the following topics:

- Setting Up Your Environment
- Starting and Testing a Message Broker
- Developing a Client Application
- Compiling and Running a Client Application
- Deploying a Client Application
- Example Application Code

The minimum Java Development Kit (JDK) level required to compile and run Message Queue clients is 1.2. For the purpose of this tutorial it is sufficient to run the Message Queue message broker in a default configuration. For instructions on configuring a message broker, see "Configuring a Broker" in *Open Message Queue Administration Guide*.

Setting Up Your Environment

The Message Queue files that need to be used in conjunction with Message Queue Java clients can be found in the `IMQ_HOME/lib` directory. Message Queue Java clients need to be able to use several `.jar` files found in this directory when these clients are compiled and run.

You need to set the `CLASSPATH` environment variable when compiling and running a JMS client.

The value of `CLASSPATH` depends on the following factors:

- The platform on which you compile or run
- The JDK version you are using
- Whether you are compiling or running a JMS application
- Whether your application uses the Simple Object Access Protocol (SOAP)
- Whether your application uses the SOAP/JMS transformer utilities

The table below lists the `.jar` files you need to compile and run different kinds of code.

Table 1–1 .jar Files Needed in CLASSPATH

Type of Code	To Compile	To Run	Remarks
JMS client	`jms.jar` `imq.jar` `jndi.jar`	`jms.jar` `imq.jar` `jndi.jar` Directory containing compiled Java application or `'.'`	See discussion of JNDI `.jar` files, following this table.
SOAP Client	`saaj-api.jar` `activation.jar`	`saaj-api.jar` Directory containing compiled Java application or `'.'`	See Working with SOAP Messages
SOAP Servlet	`jaxm-api.jar` `saaj-api.jar` `activation.jar`		GlassFish Server already includes these `.jar` files for SOAP servlet support.
Code using SOAP/JMS transformer utilities	`imqxm.jar` `.jar` files for JMS and SOAP clients	imqxm.jar	Also add the appropriate `.jar` files listed in this table for the kind of code you are writing.

A client application must be able to access the file `jndi.jar` even if the application does not use the Java Naming and Directory Interface (JNDI) directly to look up Message Queue administered objects. This is because JNDI is referenced by the `Destination` and `ConnectionFactory` classes.

JNDI `.jar` files are bundled with JDK 1.4. Thus, if you are using this JDK, you do not have to add `jndi.jar` to your `CLASSPATH` setting. However, if you are using an earlier version of the JDK, you must include `jndi.jar` in your `CLASSPATH`.

If you are using JNDI to look up Message Queue administered objects, you must also include the following files in your `CLASSPATH` setting:

- If you are using the file-system service provider for JNDI (with any JDK version), you must include the file `fscontext.jar`.
- If you are using the Lightweight Directory Access Protocol (LDAP) context
  - with JDK 1.2 or 1.3, include the files `ldabbp.jar`, and `fscontext.jar.ldap.jar`,
  - with JDK 1.4, all files are already bundled with this JDK.

Starting and Testing a Message Broker

This tutorial assumes that you do not have a Message Queue message broker currently running. (If you run the broker as a UNIX startup process or Windows service, then it is already running and you can skip to Developing a Client Application.)

To Start a Broker

1. In a terminal window, change to `IMQ_HOME/bin`, the directory containing Message Queue executables.
2. Run the broker startup command (`imqbrokerd`) as follows:

```
imqbrokerd -tty
```

The -tty option causes all logged messages to be displayed to the terminal console (in addition to the log file). The broker will start and display a few messages before displaying the message

```
imqbroker@host:7676 ready
```

The broker is now ready and available for clients to use.

To Test a Broker

One simple way to check the broker startup is by using the Message Queue command utility (imqcmd) to display information about the broker:

1. In a separate terminal window, change to the directory containing Message Queue executables (see the table shown at the beginning of the section To Start a Broker).
2. Run imqcmd with the following arguments:

   ```
   imqcmd query bkr -u admin
   ```

   Supply the default password of admin when prompted to do so. The output displayed should be similar to that shown in the next example.

Example 1–1 Output From Testing a Broker

```
% imqcmd query bkr -u admin

Querying the broker specified by:

-------------------------
Host         Primary Port
-------------------------
localhost    7676

Version                                          3.6
Instance Name                                    imqbroker
Primary Port                                     7676

Current Number of Messages in System             0
Current Total Message Bytes in System            0

Max Number of Messages in System                 unlimited (-1)
Max Total Message Bytes in System                unlimited (-1)
Max Message Size                                 70m


Auto Create Queues                               true
Auto Create Topics                               true
Auto Created Queue Max Number of Active Consumers  1
Auto Created Queue Max Number of Backup Consumers  0

Cluster Broker List (active)
Cluster Broker List (configured)
Cluster Master Broker
Cluster URL

Log Level                                        INFO
Log Rollover Interval (seconds)                  604800
Log Rollover Size (bytes)                        unlimited (-1)

Successfully queried the broker.
```

```
Current Number of Messages in System        0
```

Developing a Client Application

This section introduces the general procedures for interacting with the Message Queue API to produce and consume messages. The basic steps shown here are elaborated in greater detail in The JMS Classic API The procedures for producing and consuming messages have a number of steps in common, which need not be duplicated if the same client is performing both functions.

To Produce Messages

1. Get a connection factory.

   A Message Queue `ConnectionFactory` object encapsulates all of the needed configuration properties for creating connections to the Message Queue message service. You can obtain such an object either by direct instantiation.

   ```
   ConnectionFactory myFctry = new com.sun.messaging.ConnectionFactory();
   ```

   or by looking up a predefined connection factory using the Java Naming and Directory Interface (JNDI). In the latter case, all of the connection factory's properties will have been preconfigured to the appropriate values by your Message Queue administrator. If you instantiate the factory object yourself, you may need to configure some of its properties explicitly: for instance,

   ```
   myFctry.setProperty(ConnectionConfiguration.imqAddressList,
                         "localhost:7676, broker2:5000, broker3:9999");
   myFctry.setProperty(ConnectionConfiguration.imqReconnectEnabled, "true");
   ```

   See Obtaining a Connection Factory for further discussion.

2. Create a connection.

   A `Connection` object is an active connection to the Message Queue message service, created by the connection factory you obtained in Developing a Client Application:

   ```
   Connection myConnection = myFactory.createConnection();
   ```

   See Using Connections for further discussion.

3. Create a session for communicating with the message service.

   A `Session` object represents a single-threaded context for producing and consuming messages. Every session exists within the context of a particular connection and is created by that connection's `createSession` method:

   ```
   Session mySession = myConnection.createSession(false,
                                 Session.AUTO_ACKNOWLEDGE);
   ```

   The first (boolean) argument specifies whether the session is *transacted.* The second argument is the *acknowledgment mode,* such as `AUTO_ACKNOWLEDGE`, `CLIENT_ACKNOWLEDGE`, or `DUPS_OK_ACKNOWLEDGE`; these are defined as static constants in the JMS `Session` interface. See Acknowledgment Modes and Transacted Sessions for further discussion.

4. Get a destination to which to send messages.

A `Destination` object encapsulates provider-specific naming syntax and behavior for a message destination, which may be either a*queue* or a point-to-point publish/subscribe *topic* (see Messaging Domains). You can obtain such an object by direct instantiation

```
Destination myDest = new com.sun.messaging.Queue("myDest");
```

or by looking up a predefined destination using the JNDI API. See Working With Destinations for further discussion.

5. Create a message producer for sending messages to this destination.

   A `MessageProducer` object is created by a session and associated with a particular destination:

   ```
   MessageProducer myProducer = mySession.createProducer(myDest);
   ```

   See Sending Messages for further discussion.

6. Create a message.

   A `Session` object provides methods for creating each of the six types of message defined by JMS: text, object, stream, map, bytes, and null messages. For instance, you can create a text message with the statement

   ```
   TextMessage outMsg = mySession.createTextMessage();
   ```

   See Composing Messages for further discussion.

7. Set the message's content and properties.

   Each type of message has its own methods for specifying the contents of the message body. For instance, you can set the content of a text message with the statement

   ```
   outMsg.setText("Hello, World!");
   ```

   You can also use the property mechanism to define custom message properties of your own: for instance,

   ```
   outMsg.setStringProperty("MagicWord", "Shazam");
   ```

   See Working With Messages for further discussion.

8. Send the message.

   The message producer's `send` method sends a message to the destination with which the producer is associated:

   ```
   myProducer.send(outMsg);
   ```

   See Sending Messages for further discussion.

9. Close the session.

   When there are no more messages to send, you should close the session

   ```
   mySession.close();
   ```

   allowing Message Queue to free any resources it may have associated with the session. See Working With Sessions for further discussion.

10. Close the connection.

    When all sessions associated with a connection have been closed, you should close the connection by calling its `close` method:

```
myConnection.close();
```

See Using Connections for further discussion.

To Consume Messages

1. Get a connection factory.

   A Message Queue `ConnectionFactory` object encapsulates all of the needed configuration properties for creating connections to the Message Queue message service. You can obtain such an object either by direct instantiation

   ```
   ConnectionFactory myFctry = new com.sun.messaging.ConnectionFactory();
   ```

   or by looking up a predefined connection factory using the Java Naming and Directory Interface (JNDI). In the latter case, all of the connection factory's properties will have been preconfigured to the appropriate values by your Message Queue administrator. If you instantiate the factory object yourself, you may need to configure some of its properties explicitly: for instance,

   ```
   myFctry.setProperty(ConnectionConfiguration.imqAddressList,
                       "localhost:7676, broker2:5000, broker3:9999");
   myFctry.setProperty(ConnectionConfiguration.imqReconnectEnabled,"true");
   ```

   See Obtaining a Connection Factory for further discussion.

2. Create a connection.

   A `Connection` object is an active connection to the Message Queue message service, created by the connection factory you obtained in Developing a Client Application:

   ```
   Connection myConnection = myFactory.createConnection();
   ```

   See Using Connections for further discussion.

3. Create a session for communicating with the message service.

   A `Session` object represents a single-threaded context for producing and consuming messages. Every session exists within the context of a particular connection and is created by that connection's `createSession` method:

   ```
   Session mySession = myConnection.createSession(false,
                                   Session.AUTO_ACKNOWLEDGE);
   ```

   The first (boolean) argument specifies whether the session is *transacted.* The second argument is the *acknowledgment mode,* such as `AUTO_ACKNOWLEDGE`, `CLIENT_ACKNOWLEDGE`, or `DUPS_OK_ACKNOWLEDGE`; these are defined as static constants in the JMS `Session` interface. See Acknowledgment Modes and Transacted Sessions for further discussion.

4. Get a destination from which to receive messages.

   A `Destination` object encapsulates provider-specific naming syntax and behavior for a message destination, which may be either a point-to-point *queue* or a publish/subscribe *topic* (see Messaging Domains). You can obtain such an object by direct instantiation

   ```
   Destination myDest = new com.sun.messaging.Queue("myDest");
   ```

   or by looking up a predefined destination using the JNDI API. See Working With Destinations for further discussion.

5. Create a message consumer for receiving messages from this destination.

   A `MessageConsumer` object is created by a session and associated with a particular destination:

   ```
   MessageConsumer myConsumer = mySession.createConsumer(myDest);
   ```

   See Receiving Messages for further discussion.

6. Start the connection.

   In order for a connection's message consumers to begin receiving messages, you must *start* the connection by calling its `start` method:

   ```
   myConnection.start();
   ```

   See Using Connections for further discussion.

7. Receive a message.

   The message consumer's `receive` method requests a message from the destination with which the consumer is associated:

   ```
   Message inMsg = myConsumer.receive();
   ```

   This method is used for *synchronous* consumption of messages. You can also configure a message consumer to consume messages *asynchronously,* by creating a *message listener* and associating it with the consumer. See Receiving Messages for further discussion.

8. Retrieve the message's content and properties.

   Each type of message has its own methods for extracting the contents of the message body. For instance, you can retrieve the content of a text message with the statements

   ```
   TextMessage txtMsg  = (TextMessage) inMsg;
   String      msgText = txtMsg.getText();
   ```

   In addition, you may need to retrieve some of the message's header fields: for instance,

   ```
   msgPriority = inMsg.getJMSPriority();
   ```

   You can also use message methods to retrieve custom message properties of your own: for instance,

   ```
   magicWord = inMsg.getStringProperty("MagicWord");
   ```

   See Processing Messages for further discussion.

9. Close the session.

   When there are no more messages to consume, you should close the session

   ```
   mySession.close();
   ```

   allowing Message Queue to free any resources it may have associated with the session. See Working With Sessions for further discussion.

10. Close the connection.

    When all sessions associated with a connection have been closed, you should close the connection by calling its `close` method:

    ```
    myConnection.close();
    ```

See Using Connections for further discussion.

Compiling and Running a Client Application

This section leads you through the steps needed to compile and run a simple example client application, `HelloWorldMessage`, that sends a message to a destination and then retrieves the same message from the destination. The code shown in Example 1–2 is adapted and simplified from an example program provided with the Message Queue installation: error checking and status reporting have been removed for the sake of conceptual clarity. You can find the complete original program in the `helloworld` directory in the following locations.

- Solaris: `/usr/demo/imq/`
- Linux: `opt/sun/mq/examples`
- Windows: `IMQ_HOME/demo`

Example 1–2 Simple Message Queue Client Application

```
//  Import the JMS and JNDI API classes

    import javax.jms.*;
    import javax.naming.*;
    import java.util.Hashtable;


public class HelloWorldMessage
  {

    /**
      * Main method
      *
      *   Parameter args not used
      *
    */

    public static void main (String[] args)
      {
        try
          {
            //  Get a connection factory.
            //
            //  Create the environment for constructing the initial JNDI
                        //   naming context.

                Hashtable  env = new Hashtable();


            //  Store the environment attributes that tell JNDI which
            //  initial context
            //  factory to use and where to find the provider.
            //  (On Unix, use provider URL "file:///imq_admin_objects"
            // instead of"file:///C:/imq_admin_objects".)

                env.put(Context.INITIAL_CONTEXT_FACTORY,
                        "com.sun.jndi.fscontext.RefFSContextFactory");
                env.put(Context.PROVIDER_URL,"file:///C:/imq_admin_objects");
            //  Create the initial context.

                Context  ctx = new InitialContext(env);


            //  Look up connection factory object in the JNDI object store.

                String  CF_LOOKUP_NAME = "MyConnectionFactory";
                ConnectionFactory  myFactory =
                          (ConnectionFactory) ctx.lookup(CF_LOOKUP_NAME);


            //  Create a connection.

                Connection  myConnection = myFactory.createConnection();


            //  Create a session.

                Session  mySession = myConnection.createSession(false,
                                        Session.AUTO_ACKNOWLEDGE);


            //  Look up the destination object in the JNDI object store.

                String  DEST_LOOKUP_NAME = "MyDest";
                Destination  myDest = (Destination) ctx.lookup(DEST_LOOKUP_NAME);


            //  Create a message producer.

                MessageProducer  myProducer = mySession.createProducer(myDest);


            //  Create a message consumer.

                MessageConsumer  myConsumer = mySession.createConsumer(myDest);


            //  Create a message.

                TextMessage  outMsg = mySession.createTextMessage("Hello,
World!");


            //  Send the message to the destination.

                System.out.println("Sending message: " + outMsg.getText());
                myProducer.send(outMsg);


            //  Start the connection.

                myConnection.start();


            //  Receive a message from the destination.

                Message  inMsg = myConsumer.receive();
            //  Retrieve the contents of the message.

                if (inMsg instanceof TextMessage)
                  { TextMessage  txtMsg = (TextMessage) inMsg;
                    System.out.println("Received message: " +
                                            txtMsg.getText());
                  }


            //  Close the session and the connection.

                mySession.close();
                myConnection.close();

          }

        catch (Exception jmse)
          { System.out.println("Exception occurred: " + jmse.toString() );
            jmse.printStackTrace();
          }

      }

  }
```

To compile and run Java clients in a Message Queue environment, it is recommended that you use the Java 2 SDK, Standard Edition, version 1.4 or later. You can download the recommended SDK from the following location:

http://java.sun.com/j2se/1.5

Be sure to set your CLASSPATH environment variable correctly, as described in Setting Up Your Environment, before attempting to compile or run a client application.

Note: If you are using JDK 1.5, you will get compiler errors if you use the unqualified JMS Queue class along with the following import statement.

```
import java.util.*
```

This is because the packagesjava.util and javax.jms both contain a class named Queue. To avoid the compilation errors, you must eliminate the ambiguity by either fully qualifying references to the JMS Queue class as javax.jms.Queue or correcting your import statements to refer to specific individual java.util classes.

The following steps for compiling and running the HelloWorldMessage application are furnished strictly as an example. The program is shipped precompiled; you do not actually need to compile it yourself (unless, of course, you modify its source code).

To Compile and Run the HelloWorldMessage Application

1. Make the directory containing the application your current directory.

The Message Queue example applications directory on Solaris is not writable by users, so copy the `HelloWorldMessage` application to a writable directory and make that directory your current directory.

2. Compile the `HelloWorldMessage` application:

   ```
   javac HelloWorldMessage.java
   ```

   This creates the file `HelloWorldMessage.class` in your current directory.

3. Run the `HelloWorldMessage` application:

   ```
   java HelloWorldMessage
   ```

   The program should display the following output:

   ```
       Sending Message: Hello, World!
       Received Message: Hello, World!
   ```

Deploying a Client Application

When you are ready to deploy your client application, you should make sure your Message Queue administrator knows your application's needs. The checklist shown below summarizes the information required; consult with your administrator for specific details. In some cases, it may be useful to provide a range of values rather than a specific value. See "*Managing Administered Objects*" in *Open Message Queue Administration Guide* for details on configuration and on attribute names and default values for administered objects.

- Administered Objects

  Connection Factories:

  – Type
  – JNDI lookup name
  – Other attributes

  Destinations:

  – Type (queue or topic)
  – JNDI lookup name
  – Physical destination name

- Physical Destinations

  – Type
  – Name
  – Attributes
  – Maximum number of messages expected
  – Maximum size of messages expected
  – Maximum message bytes expected

- Broker or Broker Cluster

  – Name
  – Port

  - Properties
- Dead Message Queue
  - Place dead messages on dead message queue?
  - Log placement of messages on dead message queue?
  - Discard body of messages placed on the dead message queue?

Example Application Code

The Message Queue installation includes example programs illustrating both JMS and JAXM messaging (see Working with SOAP Messages). They are located in the `IMQ_HOME/examples` directory.

Each directory (except the `JMS` directory) contains a `README` file describing the source files included in that directory. The table below lists the directories of interest to Message Queue Java clients.

Table 1–2 Example Programs

Directory	Contents
`helloworld`	Sample programs showing how to create and deploy a JMS client in Message Queue, including the steps required to create administered objects and to look up such objects with JNDI from within client code
`jms`	Sample programs demonstrating the use of the JMS API with Message Queue
`jaxm`	Sample programs demonstrating the use of SOAP messages in conjunction with JMS in Message Queue
`applications`	Four subdirectories containing source code for the following: ■ A GUI application using the JMS API to implement a simple chat application ■ A GUI application using the Message Queue JMS monitoring API to obtain a list of queues from a Message Queue broker and browse their contents with a JMS queue browser ■ The Message Queue Ping demo program ■ The Message Queue Applet demo program
`monitoring`	Sample programs demonstrating the use of the JMS API to monitor a message broker
`jdbc`	Examples for plugging in a PointBase and an Oracle database
`imqobjmgr`	Examples of `imqobjmgr` command files

2 Message Queue Clients: Design and Features

This chapter addresses architectural and configuration issues that depend upon Message Queue's implementation of the Java Message Specification. It covers the following topics:

- Client Design Considerations
- Managing Client Threads
- Managing Memory and Resources
- Programming Issues for Message Consumers
- Factors Affecting Performance
- Connection Event Notification
- Consumer Event Notification
- Client Connection Failover (Auto-Reconnect)
- Custom Client Acknowledgment
- Schema Validation of XML Payload Messages
- Communicating with C Clients
- Client Runtime Logging

Client Design Considerations

The choices you make in designing a JMS client affect portability, allocating work between connections and sessions, reliability and performance, resource use, and ease of administration. This section discusses basic issues that you need to address in client design. It covers the following topics:

- Developing Portable Clients
- Choosing which JMS API to Use
- Connections and Sessions
- Producers and Consumers
- Balancing Reliability and Performance

Developing Portable Clients

The Java Messaging Specification was developed to abstract access to message-oriented middleware systems (MOMs). A client that writes JMS code should be portable to any provider that implements this specification. If code portability is important to you, be sure that you do the following in developing clients:

- Make sure your code does not depend on extensions or features that are specific to Message Queue.
- Look up, using JNDI, (rather than instantiate) administered objects for connection factories and destinations.

  Administered objects encapsulate provider-specific implementation and configuration information. Besides allowing for portability, administered objects also make it much easier to share connection factories between applications and to tune a JMS application for performance and resource use. So, even if portability is not important to you, you might still want to leave the work of creating and configuring these objects to an administrator. For more information, see Looking Up a Connection Factory With JNDI and Looking Up a Destination With JNDI.

Choosing which JMS API to Use

As described in "Messaging Domains" in *Open Message Queue Technical Overview*, JMS supports two distinct message delivery models: point-to-point (queues) and publish/subscribe (topics). The JMS simplified and classic APIs support both domains. There are also legacy APIs specific to each domain. These four APIs are shown in Table 2–1.

Table 2–1 Interface Classes for JMS APIs

Simplified API	Classic API	Legacy API for Point-to-Point Domain	Legacy API for Publish/Subscribe Domain
`Destination`	`Destination`	`Queue`	`Topic`
`ConnectionFactory`	`ConnectionFactory`	`QueueConnectionFactory`	`TopicConnectionFactory`
`JMSContext`	`Connection`	`QueueConnection`	`TopicConnection`
	`Session`	`QueueSession`	`TopicSession`
`JMSProducer`	`MessageProducer`	`QueueSender`	`TopicPublisher`
`JMSConsumer`	`MessageConsumer`	`QueueReceiver`	`TopicSubscriber`

The JMS 2.0 specification provides the Simplified API for unified domains. It provides all the functionality of the Classic API provided by the JMS 1.1 specification but requires fewer interfaces and is simpler to use. You can choose the API that best suits your needs. The legacy domain-specific APIs continue to be supported but are not recommended for new application development.

Connections and Sessions

A connection is a relatively heavy-weight object because of the authentication and communication setup that must be done when a connection is created. For this reason, it's a good idea to use as few connections as possible. The real allocation of work occurs in sessions, which are light-weight, single-threaded contexts for producing and consuming messages. When you are thinking about structuring your client, it is best to think of the work that is done at the session level.

A session

- Is a factory for its message producers and consumers
- Supplies provider-optimized message factories
- Supports a single series of transactions that combine work spanning its producers and consumers into atomic units
- Defines a serial order for the messages it consumes and the messages it produces
- Retains messages until they have been acknowledged
- Serializes execution of message listeners registered with its message consumers

The requirement that sessions be operated on by a single thread at a time places some restrictions on the combination of producers and consumers that can use the same session. In particular, if a session has an asynchronous consumer, it may not have any other synchronous consumers. For a discussion of the connection and session's use of threads, see Managing Client Threads. With the exception of these restrictions, let the needs of your application determine the number of sessions, producers, and consumers.

JMSContext

The JMS 2.0 Specification provides the `JMSContext` object is an active connection to a JMS provider and a single-threaded context for sending and receiving messages. It is used in the Simplified API to combine the functionality of the `Connection` and `Session` object to reduce the number of objects to send and receive messages. See The JMS Simplified API.

Producers and Consumers

Aside from the reliability your client requires, the design decisions that relate to producers and consumers include the following:

- Do you want to use a point-to-point or a publish/subscribe domain?

  There are some interesting permutations here. There are times when you would want to use publish/subscribe even when you have only one subscriber. On the other hand, performance considerations might make the point-to-point model more efficient than the publish/subscribe model, when the work of sorting messages between subscribers is too costly. Sometimes You cannot make these decisions cannot in the abstract, but must actually develop and test different prototypes.

- Are you using an asynchronous message consumer that does not receive messages often or a producer that is seldom used?

  Let the administrator know how to set the ping interval, so that your client gets an exception if the connection should fail. For more information see Using the Client Runtime Ping Feature.

- Are you using a synchronous consumer in a distributed application?

  You might need to allow a small time interval between connecting and calling the `receiveNoWait()` method in order not to miss a pending message. For more information, see Synchronous Consumption in Distributed Applications.

- Do you need message compression?

Benefits vary with the size and format of messages, the number of consumers, network bandwidth, and CPU performance; and benefits are not guaranteed. For a more detailed discussion, see Message Compression.

Assigning Client Identifiers

A connection can have a *client identifier.* This identifier is used to associate a JMS client's connection to a message service, with state information maintained by the message service for that client. The JMS provider must ensure that a client identifier is unique, and applies to only one connection at a time. Currently, client identifiers are used to maintain state for durable subscribers. In defining a client identifier, you can use a special variable substitution syntax that allows multiple connections to be created from a single `ConnectionFactory` object using different user name parameters to generate unique client identifiers. These connections can be used by multiple durable subscribers without naming conflicts or lack of security.

Message Queue allows client identifiers to be set in one of two ways:

- **Programmatically:** You use the `setClientID` method of the `Connection` object. If you use this method, you must set the client id before you use the connection. Once the connection is used, the client identifier cannot be set or reset.
- **Administratively:** The administrator specifies the client ID when creating the connection factory administrative object. See "Client Identifier" in *Open Message Queue Administration Guide*.

Message Order and Priority

In general, all messages sent to a destination by a single session are guaranteed to be delivered to a consumer in the order they were sent. However, if they are assigned different priorities, a messaging system will attempt to deliver higher priority messages first.

Beyond this, the ordering of messages consumed by a client can have only a rough relationship to the order in which they were produced. This is because the delivery of messages to a number of destinations and the delivery from those destinations can depend on a number of issues that affect timing, such as the order in which the messages are sent, the sessions from which they are sent, whether the messages are persistent, the lifetime of the messages, the priority of the messages, the message delivery policy of queue destinations (see "Physical Destination Property Reference" in *Open Message Queue Administration Guide*), and message service availability.

Using Selectors Efficiently

The use of selectors can have a significant impact on the performance of your application. It's difficult to put an exact cost on the expense of using selectors since it varies with the complexity of the selector expression, but the more you can do to eliminate or simplify selectors the better.

One way to eliminate (or simplify) selectors is to use multiple destinations to sort messages. This has the additional benefit of spreading the message load over more than one producer, which can improve the scalability of your application. For those cases when it is not possible to do that, here are some techniques that you can use to improve the performance of your application when using selectors:

- Have consumers share selectors. As of version 3.5 of Message Queue, message consumers with identical selectors "share" that selector in `imqbrokerd` which can significantly improve performance. So if there is a way to structure your application to have some selector sharing, consider doing so.

- Use `IN` instead of multiple string comparisons. For example, the following expression:

  ```
  color IN ('red', 'green', 'white')
  ```

  is much more efficient than this expression

  ```
  color = 'red' OR color = 'green' OR color = 'white'
  ```

  especially if the above expression usually evaluates to false.
- Use `BETWEEN` instead of multiple integer comparisons. For example:

  ```
  size BETWEEN 6 AND 10
  ```

  is generally more efficient than

  ```
  size>= 6 AND size <= 10
  ```

  especially if the above expression usually evaluates to true.
- Order the selector expression so that Message Queue can determine its evaluation as soon as possible. (Evaluation proceeds from left to right.) This can easily double or triple performance when using selectors, depending on the complexity of the expression.
  - If you have two expressions joined by an `OR`, put the expression that is most likely to evaluate to `TRUE` first.
  - If you have two expressions joined by an `AND`, put the expression that is most likely to evaluate to `FALSE` first.

  For example, if `size` is usually greater than 6, but color is rarely `red` you'd want the order of an `OR` expression to be:

  ```
  size> 6 OR color = 'red'
  ```

  If you are using `AND`:

  ```
  color = 'red' AND size> 6
  ```

Balancing Reliability and Performance

Reliable messaging is implemented in a variety of ways: through the use of persistent messages, acknowledgments or transactions, durable subscriptions, and connection failover.

In general, the more reliable the delivery of messages, the more overhead and bandwidth are required to achieve it. The trade-off between reliability and performance is a significant design consideration. You can maximize *performance* and throughput by choosing to produce and consume nonpersistent messages. On the other hand, you can maximize *reliability* by producing and consuming persistent messages in a transaction using a transacted session. For a detailed discussion of design options and their impact on performance, see Factors Affecting Performance.

Managing Client Threads

Using client threads effectively requires that you balance performance, throughput, and resource needs. To do this, you need to understand JMS restrictions on thread usage, what threads Message Queue allocates for itself, and the architecture of your applications. This section addresses these issues and offers some guidelines for managing client threads.

JMS Threading Restrictions

The Java Messaging Specification mandates that a session not be operated on by more than one thread at a time. This leads to the following restrictions:

- A session may not have an asynchronous consumer and a synchronous consumer.
- A session that has an asynchronous consumer can only produce messages from within the `onMessage()` method (the message listener). The only call that you can make outside the message listener is to close the session.
- A session may include any number of synchronous consumers, any number of producers, and any combination of the two. That is, the single-thread requirement cannot be violated by these combinations. However, performance may suffer.

The system does not enforce the requirement that a session be single threaded. If your client application violates this requirement, you will get a `JMSIllegalState` exception or unexpected results.

Thread Allocation for Connections

When the Message Queue client runtime creates a connection, it creates two threads: one for consuming messages from the socket, and one to manage the flow of messages for the connection. In addition, the client runtime creates a thread for each client session. Thus, at a minimum, for a connection using one session, three threads are created. For a connection using three sessions, five threads are created, and so on.

Managing threads in a JMS application often involves trade-offs between performance and throughput. Weigh the following considerations when dealing with threading issues.

- When you create several asynchronous message consumers in the same session, messages are delivered serially by the session thread to these consumers. Sharing a session among several message consumers might starve some consumers of messages while inundating other consumers. If the message rate across these consumers is high enough to cause an imbalance, you might want to separate the consumers into different sessions. To determine whether message flow is unbalanced, you can monitor destinations to see the rate of messages coming in. See Using the Metrics Monitoring API.
- You can reduce the number of threads allocated to the client application by using fewer connections and fewer sessions. However, doing this might slow your application's throughput.
- You might be able to use certain JVM runtime options to improve thread memory usage and performance. For example, if you are running on the Solaris platform, you may be able to run with the same number (or more) threads by using the following `vm` options with the client: Refer to the JDK documentation for details.
  - Use the `Xss128K` option to decrease the memory size of the heap.
  - Use the `xconcurrentIO` option to improve thread performance in the 1.3 VM.

Managing Memory and Resources

This section describes memory and performance issues that you can manage by increasing JVM heap space and by managing the size of your messages. It covers the following topics:

- Managing Memory
- Managing Message Size
- Managing the Dead Message Queue
- Managing Physical Destination Limits

You can also improve performance by having the administrator set connection factory attributes to meter the message flow over the client-broker connection and to limit the message flow for a consumer. For a detailed explanation, please see "Reliability And Flow Control" in *Open Message Queue Administration Guide*.

Managing Memory

A client application running in a JVM needs enough memory to accommodate messages that flow in from the network as well as messages the client creates. If your client gets `OutOfMemoryError` errors, chances are that not enough memory was provided to handle the size or the number of messages being consumed or produced.

Your client might need more than the default JVM heap space. On most systems, the default is 64 MB but you will need to check the default values for your system.

Consider the following guidelines:

- Evaluate the normal and peak system memory footprints when sizing heap space.
- You can start by doubling the heap size using a command like the following:

  ```
  java -Xmx128m MyClass
  ```

- The best size for the heap space depends on both the operating system and the JDK release. Check the JDK documentation for restrictions.
- The size of the VM's memory allocation pool must be less than or equal to the amount of virtual memory that is available on the system.

Managing Message Size

In general, for better manageability, you can break large messages into smaller parts, and use sequencing to ensure that the partial messages sent are concatenated properly. You can also use a Message Queue JMS feature to compress the body of a message. This section describes the programming interface that allows you to compress messages and to compare the size of compressed and uncompressed messages.

Message compression and decompression is handled entirely by the client runtime, without involving the broker. Therefore, applications can use this feature with a pervious version of the broker, but they must use version 3.6 or later of the Message Queue client runtime library.

Message Compression

You can use the `Message.setBooleanProperty()` method to specify that the body of a message be compressed. If the `JMS_SUN_COMPRESS` property is set to `true`, the client runtime, will compress the body of the message being sent. This happens after the producer's send method is called and before the send method returns to the caller. The compressed message is automatically decompressed by the client runtime before the message is delivered to the message consumer.

For example, the following call specifies that a message be compressed:

```
MyMessage.setBooleanProperty("JMS_SUN_COMPRESS",true);
```

Compression only affects the message body; the message header and properties are not compressed.

Two read-only JMS message properties are set by the client runtime after a message is sent.

Applications can test the properties (`JMS_SUN_UNCOMPRESSED_SIZE` and `JMS_SUN_COMPRESSED_SIZE`) after a send returns to determine whether compression is advantageous. That is, applications wanting to use this feature, do not have to explicitly receive a compressed and uncompressed version of the message to determine whether compression is desired.

If the consumer of a compressed message wants to resend the message in an uncompressed form, it should call the `Message.clearProperties()` to clear the `JMS_SUN_COMPRESS` property. Otherwise, the message will be compressed before it is sent to its next destination.

Advantages and Limitations of Compression

Although message compression has been added to improve performance, such benefit is not guaranteed. Benefits vary with the size and format of messages, the number of consumers, network bandwidth, and CPU performance. For example, the cost of compression and decompression might be higher than the time saved in sending and receiving a compressed message. This is especially true when sending small messages in a high-speed network. On the other hand, applications that publish large messages to many consumers or who publish in a slow network environment, might improve system performance by compressing messages.

Depending on the message body type, compression may also provide minimal or no benefit. An application client can use the `JMS_SUN_UNCOMPRESSED_SIZE` and `JMS_SUN_COMPRESSED_SIZE` properties to determine the benefit of compression for different message types.

Message consumers deployed with client runtime libraries that precede version 3.6 cannot handle compressed messages. Clients wishing to send compressed messages must make sure that consumers are compatible. C clients cannot currently consume compressed messages.

Compression Examples

Example 2–1 shows how you set and send a compressed message:

Example 2–1 Sending a Compressed Message

```
//topicSession and myTopic are assumed to have been created
topicPublisher publisher = topicSession.createPublisher(myTopic);
BytesMessage bytesMessage=topicSession.createBytesMessage();

//byteArray is assumed to have been created
bytesMessage.writeBytes(byteArray);

//instruct the client runtime to compress this message
bytesMessage.setBooleanProperty("JMS_SUN_COMPRESS", true);
```

```
//publish message to the myTopic destination
publisher.publish(bytesMessage);
```

Example 2–2 shows how you examine compressed and uncompressed message body size. The `bytesMessage` was created as in Example 2–1:

Example 2–2 Comparing Compressed and Uncompressed Message Size

```
//get uncompressed body size
int uncompressed=bytesMessage.getIntProperty("JMS_SUN_UNCOMPRESSED_SIZE");

//get compressed body size
int compressed=bytesMessage.getIntProperty("JMS_SUN_COMPRESSED_SIZE");
```

Managing the Dead Message Queue

When a message is deemed undeliverable, it is automatically placed on a special queue called the dead message queue. A message placed on this queue retains all of its original headers (including its original destination) and information is added to the message's properties to explain why it became a dead message. An administrator or a developer can access this queue, remove a message, and determine why it was placed on the queue.

- For an introduction to dead messages and the dead message queue, see "Using the Dead Message Queue" in *Open Message Queue Administration Guide*.
- For a description of the destination properties and of the broker properties that control the system's use of the dead message queue, see "Physical Destination Property Reference" in *Open Message Queue Administration Guide*.

This section describes the message properties that you can set or examine programmatically to determine the following:

- Whether a dead message can be sent to the dead message queue.
- Whether the broker should log information when a message is destroyed or moved to the dead message queue.
- Whether the body of the message should also be stored when the message is placed on the dead message queue.
- Why the message was placed on the dead message queue and any ancillary information.

Message Queue 3.6 clients can set properties related to the dead message queue on messages and send those messages to clients compiled against earlier versions. However clients receiving such messages cannot examine these properties without recompiling against 3.6 libraries.

The dead message queue is automatically created by the broker and called `mq.sys.dmq.` You can use the message monitoring API, described in Using the Metrics Monitoring API, to determine whether that queue is growing, to examine messages on that queue, and so on.

You can set the properties described in Table 2–2 for any message to control how the broker should handle that message if it deems it to be undeliverable. Note that these message properties are needed only to override destination, or broker-based behavior.

Table 2–2 Message Properties Relating to Dead Message Queue

Property	Description
`JMS_SUN_PRESERVE_UNDELIVERED`	A boolean whose value determines what the broker should do with the message if it is dead. The default value of unset, specifies that the message should be handled as specified by the `useDMQ` property of the destination to which the message was sent. A value of `true` overrides the setting of the `useDMQ` property and sends the dead message to the dead message queue. A value of `false` overrides the setting of the `useDMQ` property and prevents the dead message from being placed in the dead message queue.
`JMS_SUN_LOG_DEAD_MESSAGES`	A boolean value that determines how activity relating to dead messages should be logged. The default value of unset, will behave as specified by the broker configuration property `imq.destination.logDeadMsgs`. A value of `true` overrides the setting of the `imq.destination.logDeadMsgs` broker property and specifies that the broker should log the action of removing a message or moving it to the dead message queue. A value of `false` overrides the setting of the `imq.destination.logDeadMsgs` broker property and specifies that the broker should not log these actions.
`JMS_SUN_TRUNCATE_MSG_BODY`	A boolean value that specifies whether the body of a dead message is truncated. The default value of unset, will behave as specified by the broker property `imq.destination.DMQ.truncateBody`. A value of `true` overrides the setting of the `imq.destination.DMQ.truncateBody` property and specifies that the body of the message should be discarded when the message is placed in the dead message queue. A value of `false` overrides the setting of the `imq.destination.DMQ.truncateBody` property and specifies that the body of the message should be stored along with the message header and properties when the message is placed in the dead message queue.

The properties described in Table 2–3 are set by the broker for a message placed in the dead message queue. You can examine the properties for the message to retrieve information about why the message was placed on the queue and to gather other information about the message and about the context within which this action was taken.

Table 2–3 Dead Message Properties

Property	Description
`JMS_SUN_DMQ_DELIVERY_COUNT`	An `Integer` that specifies the most number of times the message was delivered to a given consumer. This value is set only for `ERROR` or `UNDELIVERABLE` messages.
`JMS_SUN_DMQ_UNDELIVERED_TIMESTAMP`	A `Long` that specifies the time (in milliseconds) when the message was placed on the dead message queue.

`JMS_SUN_DMQ_UNDELIVERED_REASON`	A `string` that specifies one of the following values to indicate the reason why the message was placed on the dead message queue:
	`OLDEST`
	`LOW_PRIORITY`
	`EXPIRED`
	`UNDELIVERABLE`
	`ERROR`
	If the message was marked dead for multiple reasons, for example it was undeliverable and expired, only one reason will be specified by this property.
	The `ERROR` reason indicates that an internal error made it impossible to process the message. This is an extremely unusual condition, and the sender should just resend the message.

`JMS_SUN_DMQ_PRODUCING_BROKER`	A `String` used for message traffic in broker clusters: it specifies the broker name and port number of the broker that produced the message. A null value indicates the local broker.
`JMS_SUN_DMQ_DEAD_BROKER`	A `String` used for message traffic in broker clusters: it specifies the broker name and port number of the broker that placed the message on the dead message queue. A null value indicates the local broker.
`JMS_SUN_DMQ_UNDELIVERED_EXCEPTION`	A `String` that specifies the name of the exception (if the message was dead because of an exception) on either the client or the broker.
`JMS_SUN_DMQ_UNDELIVERED_COMMENT`	A `String` used to provide an optional comment when the message is marked dead.
`JMS_SUN_DMQ_BODY_TRUNCATED`	A `Boolean:` a value of `true` indicates that the message body was not stored. A value of `false` indicates that the message body was stored.

Managing Physical Destination Limits

When creating a topic or queue destination, the administrator can specify how the broker should behave when certain memory limits are reached. Specifically, when the number of messages reaching a physical destination exceeds the number specified with the `maxNumMsgs` property or when the total amount of memory allowed for messages exceeds the number specified with the `maxTotalMsgBytes` property, the broker takes one of the following actions, depending on the setting of the `limitBehavior` property:

- Slows message producers (`FLOW_CONTROL`)
- Throws out the oldest message in memory (`REMOVE_OLDEST`)
- Throws out the lowest priority message in memory (`REMOVE_LOW_PRIORITY`)
- Rejects the newest messages (`REJECT_NEWEST`)

If the default value `REJECT_NEWEST` is specified for the `limitBehavior` property, the broker throws out the newest messages received when memory limits are exceeded. If the message discarded is a persistent message, the producing client gets an exception which should be handled by resending the message later.

If any of the other values is selected for the `limitBehavior` property or if the message is not persistent, the application client is not notified if a message is discarded. Application clients should let the administrator know how they prefer this property to be set for best performance and reliability.

Programming Issues for Message Consumers

This section describes two problems that consumers might need to manage: the undetected loss of a connection, or the loss of a message for distributed synchronous consumers.

Using the Client Runtime Ping Feature

Message Queue defines a connection factory attribute for a ping interval. This attribute specifies the interval at which the client runtime should check the client's connection to the broker. The ping feature is especially useful to Message Queue clients that exclusively receive messages and might therefore not be aware that the absence of messages is due to a connection failure. This feature could also be useful to producers who don't send messages frequently and who would want notification that a connection they're planning to use is not available.

The connection factory attribute used to specify this interval is called `imqPingInterval`. Its default value is 30 seconds. A value of -1 or 0, specifies that the client runtime should not check the client connection.

Developers should set (or have the administrator set) ping intervals that are slightly more frequent than they need to send or receive messages, to allow time to recover the connection in case the ping discovers a connection failure. Note also that the ping may not occur at the exact time specified by the value you supply for `interval`; the underlying operating system's use of i/o buffers may affect the amount of time needed to detect a connection failure and trigger an exception.

A failed ping operation results in a `JMSException` on the subsequent method call that uses the connection. If an exception listener is registered on the connection, it will be called when a ping operation fails.

Preventing Message Loss for Synchronous Consumers

It is always possible that a message can be lost for synchronous consumers in a session using `AUTO_ACKNOWLEDGE` mode if the provider fails. To prevent this possibility, you should either use a transacted session or a session in `CLIENT_ACKNOWLEDGE` mode.

Synchronous Consumption in Distributed Applications

Because distributed applications involve greater processing time, such an application might not behave as expected if it were run locally. For example, calling the `receiveNoWait` method for a synchronous consumer might return `null` even when there is a message available to be retrieved.

If a client connects to the broker and immediately calls the `receiveNoWait` method, it is possible that the message queued for the consuming client is in the process of being transmitted from the broker to the client. The client runtime has no knowledge of what is on the broker, so when it sees that there is no message available on the client's internal queue, it returns with a `null`, indicating no message.

You can avoid this problem by having your client do either of the following:

- Use one of the synchronous receive methods that specifies a timeout interval.
- Use a queue browser to check the queue before calling the `receiveNoWait` method.

Factors Affecting Performance

Application design decisions can have a significant effect on overall messaging performance. The most important factors affecting performance are those that impact the reliability of message delivery; among these are the following:

- Delivery Mode (Persistent/Nonpersistent)
- Use of Transactions
- Acknowledgment Mode
- Durable vs. Nondurable Subscriptions

Other application design factors impacting performance include the following:

- Use of Selectors (Message Filtering)
- Message Size
- Message Body Type

The sections that follow describe the impact of each of these factors on messaging performance. As a general rule, there is a trade-off between performance and reliability: factors that increase reliability tend to decrease performance.

Table 2–4 shows how application design factors affect messaging performance. The table shows two scenarios—a high-reliability, low-performance scenario and a high-performance, low-reliability scenario—and the choice of application design factors that characterizes each. Between these extremes, there are many choices and trade-offs that affect both reliability and performance.

Table 2–4 Comparison of High Reliability and High Performance Scenarios

Application Design Factor	High Reliability, Low Performance	High Performance, Low Reliability
Delivery mode	Persistent messages	Nonpersistent messages
Use of transactions	Transacted sessions	No transactions
Acknowledgment mode	`AUTO_ACKNOWLEDGE` `CLIENT_ACKNOWLEDGE`	`DUPS_OK_ACKNOWLEDGE` `NO_ACKNOWLEDGE`
Durable/nondurable subscriptions	Durable subscriptions	Nondurable subscriptions
Use of selectors	Message filtering	No message filtering
Message size	Small messages	Large messages
Message body type	Complex body types	Simple body types

Delivery Mode (Persistent/Nonpersistent)

Persistent messages guarantee message delivery in case of broker failure. The broker stores these message in a persistent store until all intended consumers acknowledge that they have consumed the message.

Broker processing of persistent messages is slower than for nonpersistent messages for the following reasons:

- A broker must reliably store a persistent message so that it will not be lost should the broker fail.
- The broker must confirm receipt of each persistent message it receives. Delivery to the broker is guaranteed once the method producing the message returns without an exception.
- Depending on the client acknowledgment mode, the broker might need to confirm a consuming client's acknowledgment of a persistent message.

For both queues and topics with durable subscribers, performance was approximately 40% faster for non-persistent messages. We obtained these results using 10K-size messages and `AUTO_ACKNOWLEDGE` mode.

Use of Transactions

A transaction guarantees that all messages produced in a transacted session and all messages consumed in a transacted session will be either processed or not processed (rolled back) as a unit. Message Queue supports both local and distributed transactions.

A message produced or acknowledged in a transacted session is slower than in a non-transacted session for the following reasons:

- Additional information must be stored with each produced message.
- In some situations, messages in a transaction are stored when normally they would not be. For example, a persistent message delivered to a topic destination with no subscriptions would normally be deleted, however, at the time the transaction is begun, information about subscriptions is not available.
- Information on the consumption and acknowledgment of messages within a transaction must be stored and processed when the transaction is committed.

Acknowledgment Mode

Other than using transactions, you can ensure reliable delivery by having the client acknowledge receiving a message. If a session is closed without the client acknowledging the message or if the message broker fails before the acknowledgment is processed, the broker redelivers that message, setting a `JMSRedelivered` flag.

For a non-transacted session, the client can choose one of three acknowledgment modes, each of which has its own performance characteristics:

- `AUTO_ACKNOWLEDGE`. The system automatically acknowledges a message once the consumer has processed it. This mode guarantees at most one redelivered message after a provider failure.
- `CLIENT_ACKNOWLEDGE`. The application controls the point at which messages are acknowledged. All messages processed in that session since the previous acknowledgment are acknowledged. If the broker fails while processing a set of acknowledgments, one or more messages in that group might be redelivered.

  (Using `CLIENT_ACKNOWLEDGE` mode is similar to using transactions, except there is no guarantee that all acknowledgments will be processed together if a provider fails during processing.)
- `DUPS_OK_ACKNOWLEDGE`. This mode instructs the system to acknowledge messages in a lazy manner. Multiple messages can be redelivered after a provider failure.

- `NO_ACKNOWLEDGE` In this mode, the broker considers a message acknowledged as soon as it has been written to the client. The broker does not wait for an acknowledgment from the receiving client. This mode is best used by typic subscribers who are not worried about reliability.

Performance is impacted by acknowledgment mode for the following reasons:

- Extra control messages between broker and client are required in `AUTO_ACKNOWLEDGE` and `CLIENT_ACKNOWLEDGE` modes. The additional control messages add processing overhead and can interfere with JMS payload messages, causing processing delays.
- In `AUTO_ACKNOWLEDGE` and `CLIENT_ACKNOWLEDGE` modes, the client must wait until the broker confirms that it has processed the client's acknowledgment before the client can consume more messages. (This broker confirmation guarantees that the broker will not inadvertently redeliver these messages.)
- The Message Queue persistent store must be updated with the acknowledgment information for all persistent messages received by consumers, thereby decreasing performance.

Durable vs. Nondurable Subscriptions

Subscribers to a topic destination have either durable and nondurable subscriptions. Durable subscriptions provide increased reliability at the cost of slower throughput for the following reasons:

- The Message Queue message broker must persistently store the list of messages assigned to each durable subscription so that should the broker fail, the list is available after recovery.
- Persistent messages for durable subscriptions are stored persistently, so that should a broker fail, the messages can still be delivered after recovery, when the corresponding consumer becomes active. By contrast, persistent messages for nondurable subscriptions are not stored persistently (should a broker fail, the corresponding consumer connection is lost and the message would never be delivered).

We compared performance for durable and non-durable subscribers in two cases: persistent and nonpersistent 10k-sized messages. Both cases use `AUTO_ACKNOWLEDGE` acknowledgment mode. We found a performance impact only in the case of persistent messages, which slowed messages conveyed to durable subscribers by about 30%.

Use of Selectors (Message Filtering)

Application developers can have the messaging provider sort messages according to criteria specified in the message selector associated with a consumer and deliver to that consumer only those messages whose property value matches the message selector. For example, if an application creates a subscriber to the topic `WidgetOrders` and specifies the expression `NumberOfOrders>1000` for the message selector, messages with a `NumberOfOrders` property value of `1001` or more are delivered to that subscriber.

Creating consumers with selectors lowers performance (as compared to using multiple destinations) because additional processing is required to handle each message. When a selector is used, it must be parsed so that it can be matched against future messages. Additionally, the message properties of each message must be retrieved and compared against the selector as each message is routed. However, using selectors provides more flexibility in a messaging application and may lower resource requirements at the expense of speed.

Message Size

Message size affects performance because more data must be passed from producing client to broker and from broker to consuming client, and because for persistent messages a larger message must be stored.

However, by batching smaller messages into a single message, the routing and processing of individual messages can be minimized, providing an overall performance gain. In this case, information about the state of individual messages is lost.

In our tests, which compared throughput in kilobytes per second for 1K, 10K, and 100K-sized messages to a queue destination using `AUTO_ACKNOWLEDGE` mode, we found that non-persistent messaging was about 50% faster for 1K messages, about 20% faster for 10K messages, and about 5% faster for 100K messages. The size of the message affected performance significantly for both persistent and non-persistent messages. 100k messages are about 10 times faster than 10K, and 10K messages are about 5 times faster than 1K.

Message Body Type

JMS supports five message body types, shown below roughly in the order of complexity:

- **Bytes:** Contains a set of bytes in a format determined by the application
- **Text:** Is a simple `java.lang.String`
- **Stream:** Contains a stream of Java primitive values
- **Map:** Contains a set of name-and-value pairs
- **Object:** Contains a Java serialized object

While, in general, the message type is dictated by the needs of an application, the more complicated types (map and object) carry a performance cost — the expense of serializing and deserializing the data. The performance cost depends on how simple or how complicated the data is.

Connection Event Notification

Connection event notifications allow a Message Queue client to listen for closure and reconnection events and to take appropriate action based on the notification type and the connection state. For example, when a failover occurs and the client is reconnected to another broker, an application might want to clean up its transaction state and proceed with a new transaction.

If the Message Queue provider detects a serious problem with a connection, it calls the connection object's registered exception listener. It does this by calling the listener's `onException` method, and passing it a `JMSException` argument describing the problem. In the same way, the Message Queue provider offers an event notification API that allows the client runtime to inform the application about connection state changes. The notification API is defined by the following elements:

- The `com.sun.messaging.jms.notification` package, which defines the event listener and the notification event objects .
- The `com.sun.messaging.jms.Connection` interface, which defines extensions to the `javax.jms.Connection` interface.

The following sections describe the events that can trigger notification and explain how you can create an event listener.

Connection Events

The following table lists and describes the events that can be returned by the event listener.

Note that the JMS exception listener is not called when a connection event occurs. The exception listener is only called if the client runtime has exhausted its reconnection attempts. The client runtime always calls the event listener before the exception listener.

Table 2–5 Notification Events

Event Type	Meaning
`ConnectionClosingEvent`	The Message Queue client runtime generates this event when it receives a notification from the broker that a connection is about to be closed due to a shutdown requested by the administrator.
`ConnectionClosedEvent`	The Message Queue client runtime generates this event when a connection is closed due to a broker error or when it is closed due to a shutdown or restart requested by the administrator. When an event listener receives a `ConnectionClosedEvent`, the application can use the `getEventCode()` method of the received event to get an event code that specifies the cause for closure.
`ConnectionReconnectedEvent`	The Message Queue client runtime has reconnected to a broker. This could be the same broker to which the client was previously connected or a different broker. An application can use the `getBrokerAddress` method of the received event to get the address of the broker to which it has been reconnected.
`ConnectionReconnectFailedEvent`	The Message Queue client runtime has failed to reconnect to a broker. Each time a reconnect attempt fails, the runtime generates a new event and delivers it to the event listener. The JMS exception listener is not called when a connection event occurs. It is only called if the client runtime has exhausted its reconnection attempts. The client runtime always calls the event listener before the exception listener.

Creating an Event Listener

The following code example illustrates how you set a connection event listener. Whenever a connection event occurs, the event listener's `onEvent` method will be invoked by the client runtime.

```
//create an MQ connection factory.

com.sun.messaging.ConnectionFactory factory =
    new com.sun.messaging.ConnectionFactory();

//create an MQ connection.

com.sun.messaging.jms.Connection connection =
    (com.sun.messaging.jms.Connection )factory.createConnection();

//construct an MQ event listener.  The listener implements
//com.sun.messaging.jms.notification.EventListener interface.

com.sun.messaging.jms.notification.EventListener eListener =
    new ApplicationEventListener();

//set event listener to the MQ connection.
```

```
connection.setEventListener ( eListener );
```

Event Listener Examples

In this example, an application chooses to have its event listener log the connection event to the application's logging system.

```
public class ApplicationEventListener implements
    com.sun.messaging.jms.notification.EventListener {

  public void onEvent ( com.sun.messaging.jms.notification.Event connEvent ) {
    log (connEvent);
  }
  private void log ( com.sun.messaging.jms.notification.Event connEvent ) {
    String eventCode = connEvent.getEventCode();
    String eventMessage = connEvent.getEventMessage();
    //write event information to the output stream.
  }
}
```

Consumer Event Notification

Consumer event notifications allow a Message Queue client to listen for the existence of consumers on a destination. Thus, for example, a producer client can start or stop producing messages to a given destination based on the existence of consumers on the destination.

The following sections describe the events that can trigger notification and explain how you can create an event listener.

Consumer Events

The following table lists and describes the events that can be returned by the event listener.

Table 2–6 Consumer Notification Events

Event Type	Meaning
`ConsumerEvent`	This event is generated when consumer existence changes on a destination. The event has two possible event codes: `CONSUMER_READY` and `CONSUMER_NOT_READY`.

Creating a Consumer Event Listener

The following code example illustrates how you set and remove a consumer event listener. Whenever a consumer event occurs, the event listener's `onEvent` method will be invoked by the client runtime.

```
//create an MQ connection factory.

com.sun.messaging.ConnectionFactory factory =
    new com.sun.messaging.ConnectionFactory();

//create an MQ connection.

com.sun.messaging.jms.Connection connection =
    (com.sun.messaging.jms.Connection)factory.createConnection();

//create an MQ session

com.sun.messaging.jms.Session session =
    (com.sun.messaging.jms.Session)connection.createSession(false,
    Session.AUTO_ACKNOWLEDGE);

//create a queue

com.sun.messaging.Queue queue =
    (com.sun.messaging.Queue)session.createQueue(strQueueName);

//construct an MQ event listener.  The listener implements
//com.sun.messaging.jms.notification.EventListener interface.

com.sun.messaging.jms.notification.EventListener consEvtListener =
    new MyConsumerEventListener();

//set consumer event listener.

connection.setConsumerEventListener
    ( (com.sun.messaging.Destination)queue, consEvtListener );

//perform activities

//remove consumer event listener.

connection.removeConsumerEventListener
    ( (com.sun.messaging.Destination)queue );
```

Consumer Event Listener Examples

In this example, an application chooses to have its event listener set a boolean flag to give ongoing consumer availability information.

```
public class MyEventListener implements
    com.sun.messaging.jms.notification.EventListener {

  boolean consumerReady = false;

  MyEventListener(){
    consumerReady = false;
  }

  public void onEvent(com.sun.messaging.jms.notification.Event evt) {

    if (evt.getEventCode().equals(
        com.sun.messaging.jms.notification.ConsumerEvent.CONSUMER_NOT_READY
        )) {
      synchronized(this){
        consumerReady=false;
      }
    } else if (evt.getEventCode().equals(
        com.sun.messaging.jms.notification.ConsumerEvent.CONSUMER_READY
        )) {
      synchronized(this){
        consumerReady=true;
      }
```

```
        }
    }
}
```

Client Connection Failover (Auto-Reconnect)

Message Queue supports client connection failover. A failed connection can be automatically restored not only to the original broker, but to a different broker in a broker cluster. There are circumstances under which the client-side state cannot be restored on any broker during an automatic reconnection attempt; for example, when the client uses transacted sessions or temporary destinations. At such times the connection exception handler is called and the application code has to catch the exception and restore state.

This section explains how automatic reconnection is enabled, how the broker behaves during a reconnect, how automatic reconnection impacts producers and consumers, and how producers and consumers should handle exceptions that result from connection failover. For additional information about this feature, see "Connection Handling" in *Open Message Queue Administration Guide*.

Message Queue also provides a notification API that allows the client application to listen for closure and reconnection events and to respond to such events based on the notification type and the connection state. These notifications may be valuable in preparing the client for an impending event or for gathering diagnostic data. For more information, see Connection Event Notification.

Starting with version 4.1 of Message Queue, you can cluster brokers in either a *conventional cluster* or a *high-availability cluster*. The clustering model used may affect your client design. This section notes such design differences.

Enabling Auto-Reconnect

If you are using conventional clusters, you enable automatic reconnection by setting the connection factory `imqReconnectEnabled` attribute to `true`. If you are using a high availability cluster, the `imqReconnectEnabled` attribute is ignored; the client runtime will automatically reconnect to a backup broker if the connection is lost and not regained after no more than `imqReconnectAttempts` attempts. This applies to all deployment configurations: whether Message Queue is used stand alone or whether the connection is created through a resource adapter.

No matter which type of cluster you are using, you must also configure the connection factory administered object to specify the following information.

- **A list of message-service addresses** (using the `imqAddressList` attribute). Independently of the clustering model used, the client runtime uses this address list when it establishes the initial connection.

  When you connect to a conventional cluster, the client runtime also uses the address list when it tries to reestablish a connection to the message service: it attempts to connect to the brokers in the list until it finds (or fails to find) an available broker. If you specify only a single broker instance on the `imqAddressList` attribute, the configuration won't support recovery from hardware failure.

  When you specify more than one broker, you can decide whether to use parallel brokers or a broker cluster. In a parallel configuration, there is no communication between brokers, while in a broker cluster, the brokers interact to distribute message delivery loads. (Refer to "Cluster Message Delivery" in *Open Message Queue Technical Overview* for more information on broker clusters.)

– To enable parallel-broker reconnection, set the`imqAddressListBehavior` attribute to `PRIORITY` . Typically, you would specify no more than a pair of brokers for this type of reconnection. This way, the messages are published to one broker, and all clients fail over together from the first broker to the second.

– To enable clustered-broker reconnection, set the `imqAddressListBehavior` attribute to `RANDOM`. This way, the client runtime randomizes connection attempts across the list, and client connections are distributed evenly across the broker cluster.

  Each broker in a cluster uses its own separate persistent store (which means that undelivered persistent messages are unavailable until a failed broker is back online). If one broker crashes, its client connections are reestablished on other brokers.

  If you use the high availability clustering model, the address list is dynamically updated to include the brokers that are connected to the highly available database serving the cluster. In this case, the client runtime and the brokers use an internal protocol to determine which broker takes over the persistent data of the failed broker. Therefore the `imqAddressListBehavior` property does not apply to this model.

- **The number of iterations to be made over the list of brokers** (using the `imqAddressListIterations` attribute) when attempting to create a connection or to reconnect.

  For high-availability clusters, the broker will attempt to reconnect forever (no matter what value you specify for this attribute). If the client does not want this behavior, it must explicitly close the connection.

- **The number of attempts to reconnect to a broker** if the first connection fails (using the `imqReconnectAttempts` attribute).
- **The interval, in milliseconds, between reconnect attempts**, using the `imqReconnectInterval` attribute. This attribute applies to both clustering models.

Single-Broker Auto-Reconnect

Configure your connection-factory object as follows:

Example 2–3 Example of Command to Configure a Single Broker

```
imqobjmgr add -t cf -l "cn=myConnectionFactory" \
    -o "imqAddressList=mq://jpgserv/jms" \
    -o "imqReconnect=true" \
    -o "imqReconnectAttempts=10"
    -j "java.naming.factory.initial =
                  com.sun.jndi.fscontext.RefFSContextFactory
    -j "java.naming.provider.url= file:///home/foo/imq_admin_objects"
```

This command creates a connection-factory object with a single address in the broker address list. If connection fails, the client runtime will try to reconnect with the broker 10 times. If an attempt to reconnect fails, the client runtime will sleep for three seconds (the default value for the `imqReconnectInterval` attribute) before trying again. After 10 unsuccessful attempts, the application will receive a `JMSException` .

You can ensure that the broker starts automatically at system start-up time. See "Starting Brokers Automatically" in *Open Message Queue Administration Guide* for information on how to configure automatic broker start-up. For example, on the Solaris platform, you can use `/etc/rc.d` scripts.

Parallel Broker Auto-Reconnect

Configure your connection-factory objects as follows:

Example 2–4 Example of Command to Configure Parallel Brokers

```
imqobjmgr add -t cf -l "cn=myCF" \
    -o "imqAddressList=myhost1, mqtcp://myhost2:12345/jms" \
    -o "imqReconnect=true" \
    -o "imqReconnectRetries=5"
    -j "java.naming.factory.initial =
                  com.sun.jndi.fscontext.RefFSContextFactory
    -j "java.naming.provider.url= file:///home/foo/imq_admin_objects"
```

This command creates a connection factory object with two addresses in the broker list. The first address describes a broker instance running on the host `myhost1` with a standard port number (`7676`). The second address describes a `jms` connection service running at a statically configured port number (`12345`).

Clustered-Broker Auto-Reconnect

Configure your connection-factory objects as follows:

Example 2–5 Example of Command to Configure a Broker Cluster

```
imqobjmgr add -t cf -l "cn=myConnectionFactory" \
    -o "imqAddressList=mq://myhost1/ssljms, \
            mq://myhost2/ssljms, \
            mq://myhost3/ssljms, \
            mq://myhost4/ssljms" \
    -o "imqReconnect=true" \
    -o "imqReconnectRetries=5" \
    -o "imqAddressListBehavior=RANDOM"
    -j "java.naming.factory.initial =
                  com.sun.jndi.fscontext.RefFSContextFactory
    -j "java.naming.provider.url= file:///home/foo/imq_admin_objects"
```

This command creates a connection factory object with four addresses in the `imqAddressList`. All the addresses point to `jms` services running on SSL transport on different hosts. Since the `imqAddressListBehavior` attribute is set to `RANDOM`, the client connections that are established using this connection factory object will be distributed randomly among the four brokers in the address list. If you are using a high availability cluster, the `RANDOM` attribute is ignored during a failover reconnect after losing an existing connection to a broker.

For a conventional cluster, you must configure one of the brokers in the cluster as the master broker.In the connection-factory address list, you can also specify a subset of all the brokers in the cluster.

Auto-Reconnect Behaviors

A broker treats an automatic reconnection as it would a new connection. When the original connection is lost, all resources associated with that connection are released. For example, in a broker cluster, as soon as one broker fails, the other brokers assume that the client connections associated with the failed broker are gone. After auto-reconnect takes place, the client connections are recreated from scratch.

Sometimes the client-side state cannot be fully restored by auto-reconnect. Perhaps a resource that the client needs cannot be recreated. In this case, the client runtime calls the client's connection exception handler and the client must take appropriate action to restore state. For additional information, see Handling Exceptions When Failover Occurs.

If the client is automatically-reconnected to a different broker instance, effects vary depending on the clustering model used.

- In a conventional cluster, persistent messages produced but not yet consumed may only be delivered to the consumer after the original broker recovers. Other state information held by the failed or disconnected broker can be lost. The messages held by the original broker, once it is restored, might be delivered out of order.
- In a high availability cluster, messages produced but not yet consumed continue to be delivered to the consumer without the original broker needing to recover.

A transacted session is the most reliable method of ensuring that a message isn't lost if you are careful in coding the transaction. If auto-reconnect happens in the middle of a transaction, any attempt to produce or consume messages will cause the client runtime to throw a `JMSException`. In this case, applications must call `Session.rollback()` to roll back the transaction.

The Message Queue client runtime may throw a `TransactionRolledBackException` when `Session.commit()` is called during or after a failover occurs. In this case, the transaction is rolled back and a new transaction is automatically started. Applications are not required to call `Session.rollback()` to rollback the transaction after receiving a `TransactionRolledBackException`.

The Message Queue client runtime may throw a `JMSException` when `Session.commit()` is called during or after a failover occurs. In this case, the transaction state is unknown (may or may not be committed). Applications should call `Session.rollback()` to roll back the uncommitted transaction.

If you are using a high availability cluster, the only time your transaction might wind up in an unknown state is if it is not possible to reconnect to any brokers in the cluster. This should happen rarely if ever. For additional information, see Handling Exceptions When Failover Occurs.

Automatic reconnection affects producers and consumers differently:

- During reconnection, producers cannot send messages. The production of messages (or any operation that involves communication with the message broker) is blocked until the connection is reestablished.
- For consumers, automatic reconnection is supported for all client acknowledgment modes. After a connection is reestablished, the broker will redeliver all unacknowledged messages it had previously delivered, marking them with a `Redeliver` flag. The client can examine this flag to determine whether any message has already been consumed (but not yet acknowledged). In the case of nondurable subscribers, some messages might be lost because the broker does not hold their messages once their connections have been closed. Any messages produced for nondurable subscribers while the connection is down cannot be delivered when the connections is reestablished. For additional information, see Handling Exceptions When Failover Occurs.

Auto-Reconnect Limitations

Notice the following points when using the auto-reconnect feature:

- Messages might be redelivered to a consumer after auto-reconnect takes place. In auto-acknowledge mode, you will get no more than one redelivered message. In other session types, all unacknowledged persistent messages are redelivered.
- While the client runtime is trying to reconnect, any messages sent by the broker to nondurable topic consumers are lost.
- Any messages that are in queue destinations and that are unacknowledged when a connection fails are redelivered after auto-reconnect. However, in the case of queues delivering to multiple consumers, these messages cannot be guaranteed to be redelivered to the original consumers. That is, as soon as a connection fails, an unacknowledged queue message might be rerouted to other connected consumers.
- In the case of a conventional broker cluster, the failure of the master broker prevents the following operations from succeeding on any other broker in the cluster:
  - Creating or destroying a new durable subscription.
  - Creating or destroying a new physical destination using the `imqcmd create dst` command.
  - Starting a new broker process. (However, the brokers that are already running continue to function normally even if the master broker goes down.)

    You can configure the master broker to restart automatically using Message Queue broker support for `rc` scripts or the Windows service manager.
- Auto-reconnect doesn't work if the client uses a `ConnectionConsumer` to consume messages. In that case, the client runtime throws an exception.

Handling Exceptions When Failover Occurs

Several kinds of exceptions can occur as a result of the client being reconnected after a failover. How the client application should handle these exceptions depends on whether a session is transacted, on the kind of exception thrown, and on the client's role--as producer or consumer. The following sections discuss the implications of these factors.

Independently of how the exception is raised, the client application must never call `System.exit()` to exit the application because this would prevent the Message Queue client runtime from reconnecting to an alternate or restarted broker.

When a failover occurs, exception messages may be shown on the application's console and recorded in the broker's log. These messages are for information only. They may be useful in troubleshooting, but minimizing or eliminating the impact of a failover is best handled preemptively by the application client in the ways described in the following sections.

Note: Message Queue provides a notification API that allows the client application to listen for closure and reconnection events and to respond to such events based on the notification type and the connection state. These notifications may be valuable in preparing the client for an impending event or for gathering diagnostic data. For more information, see Connection Event Notification

Handling Exceptions in a Transacted Session

A transacted session might fail to commit and (throw an exception) either because a failover occurs while statements within the transaction are being executed or because the failover occurs during the call to `Session.commit()`. In the first case, the failover is said to occur during an *open transaction*; in the second case, the failover occurs during the commit itself.

In the case of a failover during an open transaction, when the client application calls `Session.commit()`, the client runtime will throw a `TransactionRolledBackException` and roll back the transaction causing the following to happen.

- Messages that have been produced (but not committed) in the transacted session are discarded and not delivered to the consumer.
- All messages that have been consumed (but not committed) in the transacted session are redelivered to the consumer with the `Redeliver` flag set.
- A new transaction is automatically started.

If the client application itself had called `Session.rollback` after a failover (before the `Session.commit` is executed) the same things would happen as if the application had received a `TransactionRollbackException.` After receiving a `TransactionRollbackException` or calling `Session.rollback()`, the client application must retry the failed transaction. That is, it must re-send and re-consume the messages that were involved in the failed-over transaction.

In the second case, when the failover occurs during a call to `Session.commit`, there may be three outcomes:

- The transaction is committed successfully and the call to `Session.commit` does not return an exception. In this case, the application client does not have to do anything.
- The runtime throws a `TransactionRolledbackException` and does not commit the transaction. The transaction is automatically rolled back by the Message Queue runtime. In this case, the client application must retry the transaction as described for the case in which an open transaction is failed-over.
- A `JMXException` is thrown. This signals the fact that the transaction state is unknown: It might have either succeeded or failed. A client application should handle this case by assuming failure, pausing for three seconds, calling `Session.rollback`, and then retrying the operations. However, since the commit might have succeeded, when retrying the transacted operations, a producer should set application-specific properties on the messages it re-sends to signal that these might be duplicate messages. Likewise, consumers that retry receive operations should not assume that a message that is redelivered is necessarily a duplicate. In other words, to ensure once and only once delivery, both producers and consumers need to do a little extra work to handle this edge case. The code samples presented next illustrate good coding practices for handling this situation.

  If you are using a high availability cluster, the only time this condition might arise is when the client is unable to connect to any backup broker. This should be extremely rare.

The next two examples illustrate how stand-alone Message Queue producers and consumers should handle transactions during a failover. To run the sample programs, do the following:

1. Start two high availability brokers. The brokers can be on the same machine or on different machines, but they must be in the same cluster.
2. Start the example programs. For example:

```
java –DimqAddressList="localhost:777"
                                    test.jmsclient.ha.FailoverQSender
```

```
java –DimqAddressList="localhost:777"
                                  test.jmsclient.ha.FailoverQReceiver
```

It does not matter in what order you start the programs. The only property that you must specify is `imqAddressList`. The client application will be automatically failed over to a backup broker if the connection to its home broker fails. (The `imqReconnectEnabled` and `imqAddressListIterations` properties are ignored for a high availability cluster.)

3. Kill the broker to which the producing or consuming application is connected. The clients will reconnect, validate, and continue the failed transaction. A message produced or consumed in a transaction is either committed or rolled back after a successful failover.
4. You can restart the dead broker and retry the failover operation by killing the new home broker.

Transacted Session: Failover Producer Example The following code sample shows the work that a producer in a transacted session needs to do to recover state after a failover. Note how the application tests both for rollback exceptions and for JMS exceptions. Note also the use of a counter to allow the producer and consumer to verify message order and delivery.

```
/*
 * @(#)FailoverQSender.java    1.2 07/04/20
 *
 * Copyright 2000 Sun Microsystems, Inc. All Rights Reserved
 * SUN PROPRIETARY/CONFIDENTIAL
 * Use is subject to license terms.
 *
 */
package test.jmsclient.ha;

import java.util.Date;
import javax.jms.*;
import com.sun.messaging.jms.Connection;
import com.sun.messaging.jms.notification.*;

/**
 *
 * This sample program uses a transacted session to send messages.
 * It is designed to run with test.jmsclient.ha.FailoverQReceiver
 * @version 1.0
 */
public class FailoverQSender
    implements ExceptionListener, EventListener, Runnable {
       //constant - commit property name
    public static final String COMMIT_PROPERTY_NAME = "COMMIT_PROPERTY";
    //constant - message counter
    public static final String MESSAGE_COUNTER = "counter";
    //constant - destination name
    public static final String TEST_DEST_NAME = "FailoverTestDest001";
    //queue connection
    QueueConnection conn = null;
    //session
    QueueSession session = null;
    //queue sender
    QueueSender sender = null;
    //queue destination
```

```
Queue queue = null;

//commmitted counter.
private int commitCounter = 0;
//current message counter
private int currentCounter = 0;
//set to true if the application is connected to the broker.
private boolean isConnected = false;

/**
 * Default constructor - do nothing.
 * Properties are passed in from init() method.
 */
public FailoverQSender() {

//set up JMS environment
     setup();
}

/**
 * Connection Exception listener.
 */
public void onException (JMSException e) {

    //The run() method will exit.
    this.isConnected = false;

    log ("Exception listener is called.
          Connection is closed by MQ client runtime." );
    log (e);
}

/**
 * this method is called when a MQ connection event occurred.
 */
public void onEvent (Event connectionEvent) {
    log(connectionEvent);
}

/**
 * Rollback the application data.
 *
 */
private void rollBackApplication() {

    this.currentCounter = this.commitCounter;
    log ("Application rolled back., current (commit) counter: "
                                          + currentCounter);
}

/**
 * Roll back the current jms session.
 */
private void rollBackJMS() {

     try {

           log("Rolling back JMS ...., commit counter: " + commitCounter);
           session.rollback();
     } catch (JMSException jmse) {
            log("Rollback failed");
            log(jmse);
            //application may decide to log and continue sending messages
            // without closing the application.
          close();
         }
}
 /**
  * rollback application data and jms session.
  *
  */
 private void rollBackAll() {
     //rollback jms
         rollBackJMS();
       //rollback app data
         rollBackApplication();
 }

 /**
  * close JMS connection and stop the application
  *
  */
 private void close() {

     try {
       if ( conn != null ) {
             //close the connection
             conn.close();
           }
      } catch (Exception e) {
           //log exception
          log (e);
      } finally {
           //set flag to true. application thread will exit
          isConnected = false;
        }
 }

 /**
  * Send messages in a loop until the connection is closed.
  * Session is committed for each message sent.
  */
 public void run () {

     //start producing messages
     while (isConnected) {

       try {
        //reset message counter if it reaches max int value
                  checkMessageCounter();
                 //create a message
                  Message m = session.createMessage();
                 //get the current message counter value
                  int messageCounter = this.getMessageCounter();
                 //set message counter to message property
                  m.setIntProperty(MESSAGE_COUNTER, messageCounter);
                 //set commit property
                  m.setBooleanProperty(COMMIT_PROPERTY_NAME, true);
                 //send the message
                  sender.send(m);
```

```
                    log("Sending message: " + messageCounter +
                                  ", current connected broker: " +
               this.getCurrentConnectedBrokerAddress());

                    //commit the message
                     this.commit();

                    // pause 3 seconds
                     sleep(3000);

                } catch (TransactionRolledBackException trbe) {
                   //rollback app data
                    rollBackApplication();
                 } catch (JMSException jmse) {
                    if (isConnected == true) {
                     //rollback app data and JMS session
                       rollBackAll();
                     }
                }
           }
   }

  /**
     * Reset all counters if integer max value is reached.
     */
    private void checkMessageCounter() {

        if ( currentCounter == Integer.MAX_VALUE ) {
           currentCounter = 0;
           commitCounter = 0;
        }
    }

  /**
     * Set up testing parameters - connection, destination, etc
     */
protected void setup() {
   try {
           //get connection factory
           com.sun.messaging.QueueConnectionFactory factory =
                           new com.sun.messaging.QueueConnectionFactory();
           //create a queue connection
           conn = factory.createQueueConnection();

           //set exception listener
           conn.setExceptionListener(this);

           //set event listener
           ( (com.sun.messaging.jms.Connection) conn).setEventListener(this);

           //get destination name
           String destName = TEST_DEST_NAME;

           //create a transacted session
           session = conn.createQueueSession(true, Session.AUTO_ACKNOWLEDGE);

           //get destination
           queue = session.createQueue(destName);
           //create queue sender
```

```
            sender = session.createSender(queue);

            //set isConnected flag to true.
            this.isConnected = true;

        } catch (JMSException jmse) {
            this.isConnected = false;
        }
    }

    /**
     * get the next message counter.
     */
    private synchronized int getMessageCounter () {
        return ++ currentCounter;
    }

    /**
     * commit the current transaction/session.
     */
    private void commit() throws JMSException {
        session.commit();
        this.commitCounter = currentCounter;

        log ("Transaction committed, commit counter: " +commitCounter);
    }

    /**
     * Get the current connencted broker address.
     */
    private String getCurrentConnectedBrokerAddress() {
        return ((com.sun.messaging.jms.Connection)conn).getBrokerAddress();
    }

    /**
     * log a string message.
     * @param msg
     */
    private synchronized void log (String msg) {
        System.out.println(new Date() + ": " + msg);
    }

    /**
     * Log an exception received.
     */
    private synchronized void log (Exception e) {
        System.out.println(new Date() + ": Exception:");
        e.printStackTrace();
    }
    /**
     * Log the specified MQ event.
     */
    private synchronized void log (Event event) {

      try {
        System.out.println(new Date() + ": Received MQ event notification.");
        System.out.println("*** Event code: " + event.getEventCode() );
        System.out.println("*** Event message: " + event.getEventMessage());
      } catch (Exception e) {
          e.printStackTrace();
      }
    }
    /**
     * pause the specified milli seconds.
     */
    private void sleep (long millis) {
      try {
         Thread.sleep(millis);
      } catch (java.lang.InterruptedException inte) {
         log (inte);
      }
    }
    /**
     * The main program.
     */
    public static void main (String args[]) {
        FailoverQSender fp = new FailoverQSender();
        fp.run();
    }
}
```

Transacted Session: Failover Consumer Example The following code sample shows the work that a consumer in a transacted session needs to do in order to recover state after a failover. Note how the application tests both for rollback exceptions and JMS exceptions. Note also the use of a counter to allow the producer and consumer to verify message order and delivery.

```
/*
 * @(#)FailoverQReceiver.java    1.4 07/04/20
 *
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 * Use is subject to license terms.
  */
package test.jmsclient.ha;

import java.util.Date;
import java.util.Vector;
import javax.jms.*;
import com.sun.messaging.jms.notification.*;

/**
 * This sample program uses a transacted session to receive messages.
 * It is designed to run with test.jmsclient.ha.FailoverQSender.
 *
 * @version 1.0
 */
public class FailoverQReceiver
    implements ExceptionListener, EventListener, Runnable {

    //queue connection
    private QueueConnection conn = null;
    //queue session
    private QueueSession session = null;
    //qreceiver
    private QueueReceiver qreceiver = null;
    //queue destination
    private Queue queue = null;
```

```
//commmitted counter.
private int commitCounter = 0;
//flag to indicate if the connection is connected to the broker.
private boolean isConnected = false;
//flag to indicate if current connection is to HA broker cluster.
private boolean isHAConnection = false;
//application data holder.
private Vector data = new Vector();

/**
 * Default constructor - JMS setup.
 */
public FailoverQReceiver() {
    //set up JMS environment
          setup();
}

/**
 * Connection Exception listener.
 */
public void onException (JMSException e) {

    //The run() method will exit.
    this.isConnected = false;

    log ("Exception listener is called. Connection is closed
                       by MQ client runtime." );
    log (e);
}

/**
 * log the connection event.
 */
public void onEvent (Event connectionEvent) {
   log (connectionEvent);
}

/**
 * Roll back application data.
 */
private void rollBackApplication() {
    //reset application data
        this.reset();

    log ("Rolled back application data, current commit counter:
         " + commitCounter);
}

/**
 * Clear the application data for the current un-committed transaction.
 */
private void reset() {
    data.clear();
}

/**
 * Roll back JMS transaction and application.
 */
private void rollBackAll() {
    try {
        //rollback JMS
            rollBackJMS();
           //rollback application data
        rollBackApplication();
    } catch (Exception e) {

        log ("rollback failed. closing JMS connection ...");

    //application may decide NOT to close connection if rollback failed.
        close();
    }
}

/**
 * Roll back jms session.
 */
private void rollBackJMS() throws JMSException {
          session.rollback();
          log("JMS session rolled back ...., commit counter:
         " + commitCounter);

   }

/**
   * Close JMS connection and exit the application.
  */
private void close() {
    try {
        if ( conn != null ) {
            conn.close();
        }
    } catch (Exception e) {
        log (e);
    } finally {
        isConnected = false;
    }
}

/**
 * Receive, validate, and commit messages.
 */
public void run () {

        //produce messages
        while (isConnected) {

             try {
        //receive message
         Message m = qreceiver.receive();
        //process message -- add message to the data holder
         processMessage(m);
        //check if the commit flag is set in the message property
         if ( shouldCommit(m) ) {
            //commit the transaction
            commit(m);
         }

           } catch (TransactionRolledBackException trbe) {
            log ("transaction rolled back by MQ  ...");
                    //rollback application data
```

```
                rollBackApplication();
               } catch (JMSException jmse) {
                      //The exception can happen when receiving messages
              //and the connected broker is killed.
                if ( isConnected == true ) {
                            //rollback MQ and application data
                    rollBackAll();
                         }

                } catch (Exception e) {
                log (e);

                //application may decide NOT to close the connection
                //when an unexpected Exception occurred.
                close();
               }
            }
    }

    /**
     * Set up testing parameters - connection, destination, etc
     */
    protected void setup() {
      try {
               //get connection factory
               com.sun.messaging.QueueConnectionFactory factory =
                 new com.sun.messaging.QueueConnectionFactory();

               //create jms connection
               conn = factory.createQueueConnection();

               //set exception listener
               conn.setExceptionListener(this);

               //set event listener
               ( (com.sun.messaging.jms.Connection) conn).setEventListener(this);

               //test if this is a HA connection
               isHAConnection = ( (com.sun.messaging.jms.Connection)
                            conn).isConnectedToHABroker();
               log ("Is connected to HA broker cluster: " + isHAConnection);

               //get destination name
               String destName = FailoverQSender.TEST_DEST_NAME;

               //create a transacted session
               session = conn.createQueueSession(true, -1);

               //get destination
               queue = session.createQueue(destName);

               //create queue receiver
               qreceiver = session.createReceiver(queue);
               //set isConnected flag to true
            isConnected = true;
        //start the JMS connection
            conn.start();
            log("Ready to receive on destination: " + destName);
        } catch (JMSException jmse) {
               isConnected = false;
                log (jmse);
        close();
     }
    }

    /**
     * Check if we should commit the transaction.
     */
    private synchronized boolean shouldCommit(Message m) {

        boolean flag = false;

        try {
            //get the commit flag set by the FailoverQSender
            flag = m.getBooleanProperty(FailoverQSender.COMMIT_PROPERTY_NAME);

            if ( flag ) {
                //check if message property contains expected message counter
                validate (m);
            }

        } catch (JMSException jmse) {
            log (jmse);
        }

        return flag;
    }

    /**
     * A very simple validation only.  More logic may be added to validate
     * message ordering and message content.
     * @param m Message  The last message received for the current transaction.
     */
    private void validate (Message m) {

      try {
       //get message counter property
         int counter = m.getIntProperty(FailoverQSender.MESSAGE_COUNTER);
       //The counter is set sequentially and must be received in right order.
       //Each message is committed after validated.
            if (counter != (commitCounter + 1)) {
                        this.printData();
                        throw new RuntimeException("validation failed.");
                    }

            log ("messages validated.  ready to commit ...");
            } catch (JMSException jmse) {
              log (jmse);

            printData();

            throw new RuntimeException("Exception occurred during validation:
                                        " + jmse);
        }
    }

    /**
     * Get the message counter and put it in the data holder.
     * @param m the current message received
     */
```

```
private synchronized void processMessage(Message m)  throws JMSException {

    // get message counter. this value is set by the FailoverQSender.
    int ct = m.getIntProperty(FailoverQSender.MESSAGE_COUNTER);
    // log the message
    log("received message: " + ct
             +", current connected broker:
    " + this.getCurrentConnectedBrokerAddress());

    // saved the data in data holder.
    data.addElement(new Integer(ct));
}

/**
 * commit the current transaction.
 * @param m the last received message to be committed.
 * @throws JMSException if commit failed.
 */
private void commit(Message m) throws JMSException {
 //commit the transaction
    session.commit();

    //get the current message counter
    int counter = m.getIntProperty(FailoverQSender.MESSAGE_COUNTER);
    //set the commit counter

    commitCounter = counter;
    //clear app data
    this.reset();

    log ("Messages committed, commitCounter: " + commitCounter);
}

/**
 * log exception.
 */
private synchronized void log (Exception e) {
System.out.println(new Date() + ": Exception Stack Trace: ");
    e.printStackTrace();
}

/**
 * log connection event.
 */
private synchronized void log (Event event) {

    try {
        System.out.println(new Date()
             + ": Received MQ event notification.");
        System.out.println("*** Event Code: " + event.getEventCode() );
        System.out.println("*** Event message: " + event.getEventMessage());
    } catch (Exception e) {
        e.printStackTrace();
    }
}

/**
 * Log the specified message.
 */
private void log (String msg) {
    System.out.println(new Date() + ": " + msg);
    }

    /**
     * print values stored in the data holder.
     *
     */
    private void printData() {

        for ( int i=0; i< data.size(); i++) {
            log (" *** data index " + i + " = " + data.elementAt(i) );
        }
    }

    private String getCurrentConnectedBrokerAddress() {
        return ((com.sun.messaging.jms.Connection)conn).getBrokerAddress();
    }
    /**
     * The main method.  This starts the failover queue receiver.
     */
    public static void main (String args[]) {
        FailoverQReceiver fqr = new FailoverQReceiver();
        fqr.run();
    }

}
```

Handling Exceptions in a Non-Transacted Session

If a connection is failed-over for a producer in a non-transacted session, a client application may receive a `JMSException`. The application thread that receives the exception should pause for a few seconds and then resend the messages. The client application may want to set a flag on the resent messages to indicate that they could be duplicates.

If a connection is failed over for a message consumer, the consequences vary with the sessions acknowledge mode:

- In client-acknowledge mode, calling `Message.acknowledge` or `MessageConsumer.receive` during a failover will raise a `JMSException`. The consumer should call `Session.recover` to recover or re-deliver the unacknowledged messages and then call `Message.acknowledge` or `MessageConsumer.receive`.
- In auto-acknowledge mode, after getting a `JMSException`, the synchronous consumer should pause a few seconds and then call `MessageConsumer.receive` to continue receiving messages. Any message that failed to be acknowledged (due to the failover) will be redelivered with the redelivered flags set to true.
- In `dups-OK-acknowledge` mode, the synchronous consumer should pause a few seconds after getting an exception and then call `MessageConsumer.receive` to continue receiving messages. In this case, it's possible that messages delivered and acknowledged (before the failover) could be redelivered.

Failover Producer Example The following code sample illustrates good coding practices for handling exceptions during a failover. It is designed to send non-transacted, persistent messages forever and to handle JMSExceptions when a failover occurs. The program is able to handle either a true or false setting for the `imqReconnectEnabled` property. To run the program enter one of the following commands.

```
java dura.example.FailoverProducer

java -DimqReconnectEnabled=true dura.example.FailoverProducer

/*
 * @(#)FailoverProducer.java    1.1 06/06/09
 * Copyright 2006 Sun Microsystems, Inc. All Rights Reserved
 * SUN PROPRIETARY/CONFIDENTIAL
 * Use is subject to license terms. */

package dura.example;

import javax.jms.*;
import com.sun.messaging.ConnectionConfiguration;
import java.util.*;

public class FailoverProducer implements ExceptionListener {

    //connection factory
    private com.sun.messaging.TopicConnectionFactory factory;
    //connection
    private TopicConnection pconn = null;
    //session
    private TopicSession psession = null;
    //publisher
    private TopicPublisher publisher = null;
    //topic
    private Topic topic = null;
    //This flag indicates whether this test client is closed.
    private boolean isClosed = false;
    //auto reconnection flag
    private boolean autoReconnect = false;
    //destination name for this example.
    private static final String DURA_TEST_TOPIC = "DuraTestTopic";
    //the message counter property name
    public static final String MESSAGE_COUNTER = "MESSAGE_COUNTER";
    //the message in-doubt-bit property name
    public static final String MESSAGE_IN_DOUBT = "MESSAGE_IN_DOUBT";

    /**
     * Constructor.  Get imqReconnectEnabled property value from
     * System property.
     */
    public FailoverProducer () {

        try {
            autoReconnect =
            Boolean.getBoolean(ConnectionConfiguration.imqReconnectEnabled);
        } catch (Exception e) {
            this.printException(e);
        }

    }

    /**
     * Connection is broken if this handler is called.
     * If autoReconnect flag is true, this is called only
     * if no more retries from MQ.
     */
    public void onException (JMSException jmse) {
```

```
    this.printException (jmse);
}

/**
 * create MQ connection factory.
 * @throws JMSException
 */
private void initFactory() throws JMSException {
    //get connection factory
    factory = new com.sun.messaging.TopicConnectionFactory();
}

/**
 * JMS setup.  Create a Connection,Session, and Producer.
 *
 * If any of the JMS object creation fails (due to system failure),
 * it retries until it succeeds.
 *
 */
private void initProducer() {

    boolean isConnected = false;

    while ( isClosed == false && isConnected == false ) {

        try {
            println("producer client creating connection ...");

            //create connection
            pconn = factory.createTopicConnection();

            //set connection exception listener
            pconn.setExceptionListener(this);

            //create topic session
            psession = pconn.createTopicSession(false,
                Session.CLIENT_ACKNOWLEDGE);

            //get destination
            topic = psession.createTopic(DURA_TEST_TOPIC);

            //publisher
            publisher = psession.createPublisher(topic);

            //set flag to true
            isConnected = true;

            println("producer ready.");
        }
        catch (Exception e) {

            println("*** connect failed ... sleep for 5 secs.");

            try {
                //close resources.
                if ( pconn != null ) {
                    pconn.close();
                }
                //pause 5 secs.
                Thread.sleep(5000);
            } catch (Exception e1) {
                ;
            }
        }
    }
}

/**
 * Start test.  This sends JMS messages in a loop (forever).
 */
public void run () {

    try {
        //create MQ connection factory.
        initFactory();

        //create JMS connection,session, and producer
        initProducer();

        //send messages forever.
        sendMessages();
    } catch (Exception e) {
        this.printException(e);
    }
}

/**
 * Send persistent messages to a topic forever.  This shows how
 * to handle failover for a message producer.
 */
private void sendMessages() {

    //this is set to true if send failed.
    boolean messageInDoubt = false;

    //message to be sent
    TextMessage m = null;

    //msg counter
    long msgcount = 0;

    while (isClosed == false) {

        try {

            /**
             * create a text message
             */
            m = psession.createTextMessage();

            /**
             * the MESSAGE_IN_DOUBT bit is set to true if
             * you get an exception for the last message.
             */
            if ( messageInDoubt == true ) {
                m.setBooleanProperty (MESSAGE_IN_DOUBT, true);
                messageInDoubt = false;

                println("MESSAGE_IN_DOUBT bit is set to true
                        for msg: " + msgcount);
            } else {
                m.setBooleanProperty (MESSAGE_IN_DOUBT, false);
            }

            //set message counter
            m.setLongProperty(MESSAGE_COUNTER, msgcount);

            //set message body
            m.setText("msg: " + msgcount);

            //send the msg
            publisher.send(m, DeliveryMode.PERSISTENT, 4, 0);

            println("sent msg: " + msgcount);

            /**
             * reset counetr if reached max long value.
             */
            if (msgcount == Long.MAX_VALUE) {
                msgcount = 0;

                println ("Reset message counter to 0.");
            }

            //increase counter
            msgcount ++;

            Thread.sleep(1000);

        } catch (Exception e) {

            if ( isClosed == false ) {

                //set in doubt bit to true.
                messageInDoubt = true;

                this.printException(e);

                //init producer only if auto reconnect is false.
                if ( autoReconnect == false ) {
                    this.initProducer();
                }
            }
        }
    }
}

/**
 * Close this example program.
 */
public synchronized void close() {

    try {
        isClosed = true;
        pconn.close();

        notifyAll();
    } catch (Exception e) {
        this.printException(e);
        }
    }

    /**
     * print the specified exception.
     * @param e the exception to be printed.
     */
    private void printException (Exception e) {
        System.out.println(new Date().toString());
        e.printStackTrace();
    }

    /**
     * print the specified message.
     * @param msg the message to be printed.
     */
    private void println (String msg) {
        System.out.println(new Date() + ": " + msg);
    }

    /**
     * Main program to start this example.
     */
    public static void main (String args[]) {
        FailoverProducer fp = new FailoverProducer();
        fp.run();
    }

}
```

Failover Consumer Example The following code sample, `FailoverConsumer,` illustrates good coding practices for handling exceptions during a failover. The transacted session is able to receive messages forever. The program sets the auto reconnect property to true, requiring the Message Queue runtime to automatically perform a reconnect when the connected broker fails or is killed. It is designed to work with the `dura.example.FailoverProducer`, shown in the previous section.

To run this program enter the following command.

```
java dura.example.FailoverConsumer
```

```
/*
 * @(#)FailoverConsumer.java    1.1 06/06/09
 * Copyright 2006 Sun Microsystems, Inc. All Rights Reserved
 * SUN PROPRIETARY/CONFIDENTIAL
 * Use is subject to license terms.
 *
 */
package dura.example;

import java.util.Date;
import javax.jms.Destination;
import javax.jms.ExceptionListener;
import javax.jms.JMSException;
import javax.jms.Message;
import javax.jms.Connection;
import javax.jms.MessageConsumer;
import javax.jms.Session;
import javax.jms.Topic;
import javax.jms.TransactionRolledBackException;
import com.sun.messaging.ConnectionConfiguration;

public class FailoverConsumer implements ExceptionListener, Runnable {

    //JMS connection
    private Connection conn = null;
    //JMS session
    private Session session = null;
    //JMS Message consumer
    private MessageConsumer messageConsumer = null;
    //JMS destination.
    private Destination destination = null;
    //flag indicates whether this program should continue running.
    private boolean isConnected = false;
    //destination name.
    private static final String DURA_TEST_TOPIC = "DuraTestTopic";
    //the commit counter, for information only.
    private long commitCounter = 0;

    /**
     * message counter property set by the producer.
     */
    public static final String MESSAGE_COUNTER = "MESSAGE_COUNTER";

    /**
     * Message in doubt bit set by the producer
     */
    public static final String MESSAGE_IN_DOUBT = "MESSAGE_IN_DOUBT";

    /**
     * receive time out
     */
    public static final long RECEIVE_TIMEOUT = 0;

    /**
     * Default constructor -
     * Set up JMS Environment.
     */
    public FailoverConsumer() {
       setup();
    }

    /*  Connection Exception listener.  This is called when connection
     *  breaks and no reconnect attempts are performed by MQ client runtime.
     */
    public void onException (JMSException e) {

        print ("Reconnect failed.  Shutting down the connection ...");

        /**
         * Set this flag to false so that the run() method will exit.
         */
        this.isConnected = false;
        e.printStackTrace();
    }

    /**
     * Best effort to roll back a jms session.  When a broker crashes, an
     * open-transaction should be rolled back.  But the re-started broker
```

```
 * may not have the uncommitted tranaction information due to system
 * failure.  In a situation like this, an application can just quit
 * calling rollback after retrying a few times  The uncommitted
 * transaction (resources) will eventually be removed by the broker.
 */
private void rollBackJMS() {

    //rollback fail count
    int failCount = 0;

    boolean keepTrying = true;

    while ( keepTrying ) {

        try {

            print ("<<< rolling back JMS ...., consumer commit counter:
                      " +  this.commitCounter);

            session.rollback();

            print("<<< JMS rolled back ...., consumer commit counter:
                      " + this.commitCounter);
            keepTrying = false;
        } catch (JMSException jmse) {

            failCount ++;
            jmse.printStackTrace();

            sleep (3000); //3 secs

            if ( failCount == 1 ) {

                print ("<<< rollback failed : total count" + failCount);
                keepTrying = false;
            }
        }
    }
}


/**
 * Close the JMS connection and exit the program.
 *
 */
private void close() {
    try {

        if ( conn != null ) {
            conn.close();
        }

    } catch (Exception e) {
        e.printStackTrace();
    } finally {
        this.isConnected = false;
    }
}

/*Receive messages in a loop until closed.*/
```

```
public void run () {

    while (isConnected) {

        try {

            /*receive message with specified timeout.*/

            Message m = messageConsumer.receive(RECEIVE_TIMEOUT);

            /* process the message. */
            processMessage(m);

            /* commit JMS transaction. */
            this.commit();

            /*increase the commit counter.*/
            this.commitCounter ++;

        } catch (TransactionRolledBackException trbe) {

            /**
             * the transaction is rolled back
             * a new transaction is automatically started.
             */
            trbe.printStackTrace();
        } catch (JMSException jmse) {

            /* The transaction is in unknown state.
    * We need to roll back the transaction.*/

            jmse.printStackTrace();

            /* roll back if not closed.
             */
            if ( this.isConnected == true ) {
                this.rollBackJMS();
            }

        } catch (Exception e) {

            e.printStackTrace();

            /* Exit if this is an unexpected Exception.
             */
            this.close();

        } finally {
            ;//do nothing
        }
    }

    print(" <<< consumer exit ...");
}

/*Set up connection, destination, etc*/
   /
protected void setup() {
        try {

            //create connection factory
            com.sun.messaging.ConnectionFactory factory =
            new com.sun.messaging.ConnectionFactory();

            //set auto reconnect to true.
            factory.setProperty(ConnectionConfiguration.imqReconnectEnabled,
"true");
            //A value of -1 will retry forever if connection is broken.
            factory.setProperty(ConnectionConfiguration.imqReconnectAttempts,
"-1");
            //retry interval - every 10 seconds
            factory.setProperty(ConnectionConfiguration.imqReconnectInterval,
"10000");
            //create connection
            conn = factory.createConnection();
            //set client ID
            conn.setClientID(DURA_TEST_TOPIC);

            //set exception listener
            conn.setExceptionListener(this);

            //create a transacted session
            session = conn.createSession(true, -1);

            //get destination
            destination = session.createTopic(DURA_TEST_TOPIC);

            //message consumer
            messageConsumer = session.createDurableSubscriber((Topic)destination,
                                                    DURA_TEST_TOPIC);
            //set flag to true
            this.isConnected = true;
            //we are ready, start the connection
            conn.start();

            print("<<< Ready to receive on destination: " + DURA_TEST_TOPIC);

        } catch (JMSException jmse) {
            this.isConnected = false;
            jmse.printStackTrace();

            this.close();
        }
    }

    /**
     * Process the received message message.
     *  This prints received message counter.
     * @param m the message to be processed.
     */
    private synchronized void processMessage(Message m) {

        try {
            //in this example, we do not expect a timeout, etc.
            if ( m == null ) {
                throw new RuntimeException ("<<< Received null message.
                                     Maybe reached max time out. ");
            }
            //get message counter property
            long msgCtr = m.getLongProperty (MESSAGE_COUNTER);

            //get message in-doubt bit
            boolean indoubt = m.getBooleanProperty(MESSAGE_IN_DOUBT);

            if ( indoubt) {
                print("<<< received message: " + msgCtr + ", indoubt bit is
true");
            } else {
                print("<<< received message: " + msgCtr);
            }

        } catch (JMSException jmse) {
            jmse.printStackTrace();
        }
    }

    /**
     * Commit a JMS transaction.
     * @throws JMSException
     */
    private void commit() throws JMSException {
        session.commit();
    }

    /**
     * Sleep for the specified time.
     * @param millis sleep time in milli-seconds.
     */
    private void sleep (long millis) {
        try {
            Thread.sleep(millis);
        } catch (java.lang.InterruptedException inte) {
            print (inte);
        }
    }

    /**
     * Print the specified message.
     * @param msg the message to be printed.
     */
    private static void print (String msg) {
        System.out.println(new Date() + ": " + msg);
    }

    /**
     * Print Exception stack trace.
     * @param e the exception to be printed.
     */
    private static void print (Exception e) {
        System.out.print(e.getMessage());
        e.printStackTrace();
    }

    /**
     * Start this example program.
     */
    public static void main (String args[]) {
        FailoverConsumer fc = new FailoverConsumer();
        fc.run();
    }

}
```

Custom Client Acknowledgment

Message Queue supports the standard JMS acknowledgment modes (auto-acknowledge, client-acknowledge, and dups-OK-acknowledge). When you create a session for a consumer, you can specify one of these modes. Your choice will affect whether acknowledgment is done explicitly (by the client application) or implicitly (by the session) and will also affect performance and reliability. This section describes additional options you can use to customize acknowledgment behavior:

- You can customize the JMS client-acknowledge mode to acknowledge one message at a time.
- If performance is key and reliability is not a concern, you can use the proprietary no-acknowledge mode to have the broker consider a message acknowledged as soon as it has been sent to the consuming client.

The following sections explain how you program these options.

Using Client Acknowledge Mode

For more flexibility, Message Queue lets you customize the JMS client-acknowledge mode. In client-acknowledge mode, the client explicitly acknowledges message consumption by invoking the `acknowledge()` method of a message object. The standard behavior of this method is to cause the session to acknowledge all messages that have been consumed by any consumer in the session since the last time the method was invoked. (That is, the session acknowledges the current message and all previously unacknowledged messages, regardless of who consumed them.)

In addition to the standard behavior specified by JMS, Message Queue lets you use client-acknowledge mode to acknowledge one message at a time.

Observe the following rules when implementing custom client acknowledgment:

- To acknowledge an individual message, call the `acknowledgeThisMessage()` method. To acknowledge all messages consumed so far, call the `acknowledgeUpThroughThisMessage()` method. Both are shown in the following code example.

  ```
  public interface com.sun.messaging.jms.Message {
            void acknowledgeThisMessage() throws JMSException;
            void acknowledgeUpThroughThisMessage() throws JMSException;
  }
  ```

- When you compile the resulting code, include both `imq.jar` and `jms.jar` in the class path.
- Don't call `acknowledge()`, `acknowledgeThisMessage()` , or `acknowledgeUpThroughThisMessage()` in any session except one that uses client-acknowledge mode. Otherwise, the method call is ignored.
- Don't use custom acknowledgment in transacted sessions. A transacted session defines a specific way to have messages acknowledged.

If a broker fails, any message that was not acknowledged successfully (that is, any message whose acknowledgment ended in a `JMSException`) is held by the broker for delivery to subsequent clients.

Example 2–6 demonstrates both types of custom client acknowledgment.

Example 2–6 Example of Custom Client Acknowledgment Code

```
...
import javax.jms.*;
...[Look up a connection factory and create a connection.]

    Session session = connection.createSession(false,
                       Session.CLIENT_ACKNOWLEDGE);

...[Create a consumer and receive messages.]

    Message message1 = consumer.receive();
    Message message2 = consumer.receive();
    Message message3 = consumer.receive();

...[Process messages.]

...[Acknowledge one individual message.
   Notice that the following acknowledges only message 2.]

    ((com.sun.messaging.jms.Message)message2).acknowledgeThisMessage();

...[Continue. Receive and process more messages.]

    Message message4 = consumer.receive();
    Message message5 = consumer.receive();
    Message message6 = consumer.receive();

...[Acknowledge all messages up through message 4. Notice that this
    acknowledges messages 1, 3, and 4, because message 2 was acknowledged
    earlier.]

    ((com.sun.messaging.jms.Message)message4).acknowledgeUpThroughThisMessage();
...[Continue. Finally, acknowledge all messages consumed in the session.
    Notice that this acknowledges all remaining consumed messages, that is,
    messages 5 and 6, because this is the standard behavior of the JMS API.]

    message5.acknowledge();
```

Using No Acknowledge Mode

No-acknowledge mode is a nonstandard extension to the JMS API. Normally, the broker waits for a client acknowledgment before considering that a message has been acknowledged and discarding it. That acknowledgment must be made programmatically if the client has specified client-acknowledge mode or it can be made automatically, by the session, if the client has specified auto-acknowledge or dups-OK-acknowledge. If a consuming client specifies no-acknowledge mode, the broker discards the message as soon as it has sent it to the consuming client. This feature is intended for use by nondurable subscribers consuming nonpersistent messages, but it can be used by any consumer.

Using this feature improves performance by reducing protocol traffic and broker work involved in acknowledging a message. This feature can also improve performance for brokers dealing with misbehaving clients who do not acknowledge messages and therefore tie down broker memory resources unnecessarily. Using this mode has no effect on producers.

You use this feature by specifying `NO_ACKNOWLEDGE` for the `acknowledgeMode` parameter to the `createSession`, `createQueueSession`, or `createTopicSession` method. No-acknowledge mode must be used only with the connection methods defined in the `com.sun.messaging.jms` package. Note however that the connection itself must be created using the `javax.jms` package.

The following are sample variable declarations for `connection`, `queueConnection` and `topicConnection`:

```
javax.jms.connection Connection;
javax.jms.queueConnection queueConnection
javax.jms.topicConnection topicConnection
```

The following are sample statements to create different kinds of no-acknowledge sessions:

```
//to create a no ack session
Session noAckSession  =
     ((com.sun.messaging.jms.Connection)connection)
    .createSession(com.sun.messaging.jms.Session.NO_ACKNOWLEDGE);

// to create a no ack topic session
TopicSession noAckTopicSession  =
     ((com.sun.messaging.jms.TopicConnection) topicConnection)
    .createTopicSession(com.sun.messaging.jms.Session.NO_ACKNOWLEDGE);

//to create a no ack queue session
QueueSession noAckQueueSession  =
     ((com.sun.messaging.jms.QueueConnection) queueConnection)
    .createQueueSession(com.sun.messaging.jms.Session.NO_ACKNOWLEDGE);
```

Specifying no-acknowledge mode for a session results in the following behavior:

- The client runtime will throw a `JMSException` if `Session.recover()` is called.
- The client runtime will ignore a call to the `Message.acknowledge()` method from a consumer.
- Messages can be lost. As opposed to `dups-OK-acknowledge`, which can result in duplicate messages being sent, no-acknowledge mode bypasses checks and balances built into the system and may result in message loss.

Schema Validation of XML Payload Messages

This Message Queue feature enables validation of the content of a text (not object) XML message against an XML schema at the point the message is sent to the broker.

When XML validation is enabled, the Message Queue client runtime will attempt to validate an XML message against specified XSDs before sending the message to the broker. The location of the XML schema (XSD) is specified as a property of a Message Queue destination. If the specified schema cannot be located or the message cannot be validated, the message is not sent, and an exception is thrown.

If no XSD location is specified, the DTD declaration within the XML document is used to perform DTD validation. (XSD validation, which includes data type and value range validation, is more rigorous than DTD validation.)

Client applications using this feature should upgrade Java SE version to JRE 1.5 or above.

XML schema validation is enabled using the following physical destination properties: `validateXMLSchemaEnabled`, `XMLSchemaURIList`, and `reloadXMLSchemaOnFailure`. These properties are described in "Physical Destination Property Reference" in *Open Message Queue Administration Guide*. The property values can be set at destination creation or update time by using the `imqcmd create dst` or `imqcmd update dst` command, respectively. The XML validation properties should be set when a destination is inactive: that is, when it has no consumers and producers, and when there are no messages in the destination.

If any of the XML validation properties are set while a destination is active (for example, if a producer is connected to the destination), the change will not take effect until the producer reconnects to the broker. Similarly, if an XSD is changed, as a result of changing application requirements, all client applications producing XML messages based on the changed XSD must reconnect to the broker.

If the `reloadXMLSchemaOnFailure` property is set to `true` and XML validation fails, then the Message Queue client runtime will attempt to reload the XSD before attempting again to validate a message. The client runtime will throw an exception if the validation fails using the reloaded XSD.

Communicating with C Clients

Message Queue supports C clients as message producers and consumers.

A Java client consuming messages sent by a C client faces only one restriction: a C client cannot be part of a distributed transaction, and therefore a Java client receiving a message from a C client cannot participate in a distributed transaction either.

A Java client producing messages for a consuming C client must be aware of the following differences in the Java and C interfaces because these differences will affect the C client's ability to consume messages: C clients

- Can only consume messages of type `text` and `bytes`
- Cannot consume messages whose body has been compressed
- Cannot participate in distributed transactions
- Cannot receive SOAP messages

Client Runtime Logging

This section describes support for client runtime logging of connection and session-related events.

JDK 1.4 (and above) includes the `java.util.logging` library. This library implements a standard logger interface that can be used for application-specific logging.

The Message Queue client runtime uses the Java Logging API to implement its logging functions. You can use all the J2SE 1.4 logging facilities to configure logging activities. For example, an application can use the following Java logging facilities to configure how the Message Queue client runtime outputs its logging information:

- Logging Handlers
- Logging Filters
- Logging Formatters

- Logging Level

For more information about the Java Logging API, please see the Java Logging Overview at
`http://download.oracle.com/javase/1.4.2/docs/guide/util/logging/overview.html`

Logging Name Spaces, Levels, and Activities

The Message Queue provider defines a set of logging name spaces associated with logging levels and logging activities that allow Message Queue clients to log connection and session events when a logging configuration is appropriately set.

The root logging name space for the Message Queue client runtime is defined as `javax.jms`. All loggers in the Message Queue client runtime use this name as the parent name space.

The logging levels used for the Message Queue client runtime are the same as those defined in the `java.util.logging.Level` class. This class defines seven standard log levels and two additional settings that you can use to turn logging on and off.

`OFF`
Turns off logging.

`SEVERE`
Highest priority, highest value. Application-defined.

`WARNING`
Application-defined.

`INFO`
Application-defined.

`CONFIG`
Application-defined

`FINE`
Application-defined.

`FINER`
Application-defined.

`FINEST`
Lowest priority, lowest value. Application-defined.

`ALL`
Enables logging of all messages.

In general, exceptions and errors that occur in the Message Queue client runtime are logged by the logger with the `javax.jms` name space.

- Exceptions thrown from the JVM and caught by the client runtime, such as `IOException`, are logged by the logger with the logging name space `javax.jms` at level `WARNING`.
- JMS exceptions thrown from the client runtime, such as `IllegalStateException`, are logged by the logger with the logging name space `javax.jms` at level `FINER`.

- Errors thrown from the JVM and caught by the client runtime, such as `OutOfMemoryError`, are logged by the logger with the logging name space `javax.jms` at level `SEVERE`.

The following tables list the events that can be logged and the log level that must be set to log events for JMS connections and for sessions.

The following table describes log levels and events for connections.

Table 2–7 Log Levels and Events for `javax.jms.connection` Name Space

Log Level	Events
`FINE`	Connection created
`FINE`	Connection started
`FINE`	Connection closed
`FINE`	Connection broken
`FINE`	Connection reconnected
`FINER`	Miscellaneous connection activities such as `setClientID`
`FINEST`	Messages, acknowledgments, Message Queue action and control messages (like committing a transaction)

For sessions, the following information is recorded in the log record.

- Each log record for a message delivered to a consumer includes ConnectionID, SessionID, and ConsumerID.
- Each log record for a message sent by a producer includes ConnectionID, SessionID, ProducerID, and destination name.

The table below describes log levels and events for sessions.

Table 2–8 Log Levels and Events for `javax.jms.session` Name Space

Log Level	Event
`FINE`	Session created
`FINE`	Session closed
`FINE`	Producer created
`FINE`	Consumer created
`FINE`	Destination created
`FINER`	Miscellaneous session activities such as committing a session.
`FINEST`	Messages produced and consumed. (Message properties and bodies are not logged in the log records.)

By default, the output log level is inherited from the JRE in which the application is running. Check the `JRE_DIRECTORY/lib/logging.properties` file to determine what that level is.

You can configure logging programmatically or by using configuration files, and you can control the scope within which logging takes place. The following sections describe these possibilities.

Using the JRE Logging Configuration File

The following example shows how you set logging name spaces and levels in the `JRE_DIRECTORY/lib/logging.properties` file, which is used to set the log level for the Java runtime environment. All applications using this JRE will have the same logging configuration. The sample configuration below sets the logging level to `INFO` for the `javax.jms.connection` name space and specifies that output be written to `java.util.logging.ConsoleHandler`.

```
#logging.properties file.
# "handlers" specifies a comma separated list of log Handler
# classes. These handlers will be installed during VM startup.
# Note that these classes must be on the system classpath.
# By default we only configure a ConsoleHandler, which will only
# show messages at the INFO and above levels.

    handlers= java.util.logging.ConsoleHandler

# Default global logging level.
# This specifies which kinds of events are logged across
# all loggers. For any given facility this global level
# can be overriden by a facility-specific level.
# Note that the ConsoleHandler also has a separate level
# setting to limit messages printed to the console.

    .level= INFO

# Limit the messages that are printed on the console to INFO and above.

    java.util.logging.ConsoleHandler.level = INFO
    java.util.logging.ConsoleHandler.formatter =
                                java.util.logging.SimpleFormatter

# The logger with javax.jms.connection name space will write
# Level.INFO messages to its output handler(s). In this configuration
# the ouput handler is set to java.util.logging.ConsoleHandler.

    javax.jms.connection.level = INFO
```

Using a Logging Configuration File for a Specific Application

You can also define a logging configuration file from the java command line that you use to run an application. The application will use the configuration defined in the specified logging file. In the following example, `configFile` uses the same format as defined in the `JRE_DIRECTORY/lib/logging.properties` file.

```
java -Djava.util.logging.config.file=configFile MQApplication
```

Setting the Logging Configuration Programmatically

The following code uses the `java.util.logging` API to log connection events by changing the `javax.jms.connection` name space log level to `FINE`. You can include such code in your application to set logging configuration programmatically.

```
import java.util.logging.*;
//construct a file handler and output to the mq.log file
//in the system's temp directory.
```

```
    Handler fh = new FileHandler("%t/mq.log");
    fh.setLevel (Level.FINE);

//Get Logger for "javax.jms.connection" domain.

    Logger logger = Logger.getLogger("javax.jms.connection");
    logger.addHandler (fh);

//javax.jms.connection logger would log activities
//with level FINE and above.

    logger.setLevel (Level.FINE);
```

3

The JMS Simplified API

This chapter describes the JMS Simplified API defined by the Java Message Service (JMS) 2.0 specification and implemented in the Message Queue Java API.

Note: The JMS Classic API offers the same functionality and is described in The JMS Classic API. For detailed reference information, see the JavaDoc documentation for each individual class.

The topics covered include the following:

- Using the Simplified API
- Developing a JMS Client using the Simplified API
- Working With Connections
- Working With Destinations
- Working With Messages

Using the Simplified API

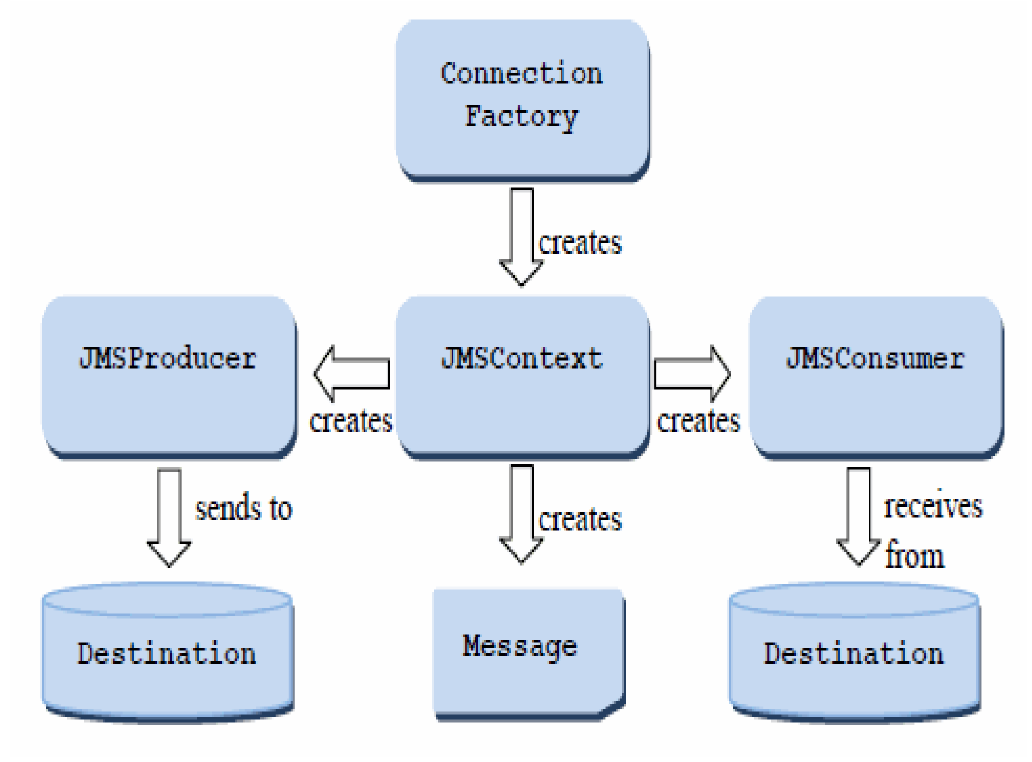
The Simplified API provides the same basic functionality as the Classic API but requires fewer interfaces and is simpler to use.

The main interfaces are:

- `ConnectionFactory`—An administered object used by a client to create a `Connection`. This interface is also used by the Classic API.
- `JMSContext`—An active connection to a JMS provider and a single-threaded context used to send or receive messages.
- `JMSProducer`—An object created by a `JMSContext` to send messages to a queue or topic.
- `JMSConsumer`—An object created by a `JMSContext` to receive messages sent to a.queue or topic

In the Simplified API, the `JMSContext` combines the behaviors of the Classic API `Connection` and `Session` objects. A `Connection` continues to represent a physical link to a JMS server. A `Session` continues to represent a single-threaded context for sending or receiving messages. Figure 3–1 shows an overview of the Simplified API.

Figure 3–1 Overview of Simplified API



The JMS 2.0 specification is backward compatible with previous JMS specifications. You can choose the API that best suits your needs. However, the legacy domain-specific APIs are only provided for compatibility with legacy applications and are not supported for new application development. Table 2–1 compares the API classes for all supported messaging domains.

For more information, see "The Java Message Service specification, version 2.0", available from http://jcp.org/en/jsr/detail?id=343.

Using the Autocloseable Interface

Objects from interfaces that extend the `java.lang.Autocloseable` and use a `try-with-resources` statement do not need to explicitly call `close()` when these objects are no longer required.

The following interfaces extend the `java.lang.Autocloseable` interface:

- `JMSContext`
- `JMSConsumer`
- `QueueBrowser`

For example:

```
. . .
try (JMSContext context = connectionFactory.createContext();){
   // use context in this try block
   // it will be closed when try block completes
} catch (JMSException e){
   // exception handling
}
```

. . .

Simplified Extraction of Message Bodies

You can use the `getBody` method to provide a convenient way to obtain the body from a newly-received `Message` object. Use `getBody` to:

- Return the body of a `TextMessage`, `MapMessage`, or `BytesMessage` as a `String`, `Map`, or `byte[]` without the need to cast the `Message` first to the appropriate subtype.
- Return the body of an `ObjectMessage` without the need to cast the `Message` to `ObjectMessage`, extract the body as a `Serializable`, and cast it to the specified type.

The `isBodyAssignableTo` method can be used to determine whether a subsequent call to `getBody` would be able to return the body of a particular `Message` object as a particular type.

Developing a JMS Client using the Simplified API

This section provides the basic steps required to create a JMS client using the Simplified API.

- Use JNDI to find a `ConnectionFactory` object.
- Use JNDI to find one or more `Destination` objects.
- Use the `ConnectionFactory` to create a `JMSContext` object.
- Use the `JMSContext` to create the `JMSProducer` and `JMSConsumer` objects needed.
- Delivery of message is started automatically.

Example 3–1 Sending a Message using the Simplified API

```
public void sendMessageNew(String body) throws NamingException{

   InitialContext initialContext = getInitialContext();
   ConnectionFactory connectionFactory = (ConnectionFactory)
      initialContext.lookup("jms/connectionFactory");

   Queue inboundQueue = (Queue) initialContext.lookup("jms/inboundQueue");

   try (JMSContext context = connectionFactory.createContext();){
      context.createProducer().send(inboundQueue,body);
   }
}
. . .
```

See "Java Message Service Examples" in *The Java EE 7 Tutorial* for additional information.

Working With Connections

In the simplified API a connection and a session are represented by a single `JMSContext` object. When a `JMSContext` is created the underlying session is created automatically.

Since a `JMSContext` incorporates a session, it is subject to the same threading restrictions as a session. This means that it may only be used by one thread at a time (single-threaded).

- The `JMSContext` method `createContext` does not use its underlying session and is not subject to the single-threading restriction.
- The `close` method on `JMSContext` or `JMSConsumer` is not single-threaded since closing a session or consumer from another thread is permitted.
- By default, when `createConsumer` or `createDurableConsumer` is used to create a `JMSConsumer`, the connection is automatically started. If `setMessageListener` is called to configure the asynchronous delivery of messages, the `JMSContext`'s session immediately becomes dedicated to the thread of control that delivers messages to the listener. The application must not subsequently call methods on the `JMSContext` from another thread of control. However, this restriction does not apply to applications which call `setMessageListener` to set a second or subsequent message listener. The JMS provider is responsible for ensuring that a second message listener may be safely configured even if the underlying connection has been started.

See "The JMS API Programming Model" in *The Java EE 7 Tutorial* for additional information.

Working With Destinations

All Message Queue messages travel from a message producer to a message consumer by way of a *destination* on a message broker. Message delivery is thus a two-stage process: the message is first delivered from the producer to the destination and later from the destination to the consumer. Physical destinations on the broker are created administratively by a Message Queue administrator, using the administration tools described in "Configuring and Managing Physical Destinations" in *Open Message Queue Administration Guide*. The broker provides routing and delivery services for messages sent to such a destination.

Message Queue supports two types of destination, depending on the messaging domain being used:

- Queues (point-to-point domain)
- Topics (publish/subscribe domain)

These two types of destination are represented by the Message Queue classes `Queue` and `Topic`, respectively. These, in turn, are both subclasses of the generic class `Destination`. A client program that uses the `Destination` superclass can thus handle both queue and topic destinations indiscriminately.

See "The JMS API Programming Model" in *The Java EE 7 Tutorial* for additional information.

Working With Messages

This section describes how to use the Message Queue Java API to compose, send, receive, and process messages. See "The JMS API Programming Model" in *The Java EE 7 Tutorial* for additional information.

Message Structure

The following section provides information on message structure:

- A *header* containing identifying and routing information.
- Optional *properties* that can be used to convey additional identifying information beyond that contained in the header
- A *body* containing the actual content of the message.

For more information, see Message Structure.

Message Headers

Every message must have a *header* containing identifying and routing information. The header consists of a set of standard fields, which are defined in the *Java Message Service Specification* and summarized in Table 3–1. Some of these are set automatically by Message Queue in the course of producing and delivering a message, some depend on settings specified when a message producer sends a message, and others are set by the client on a message-by-message basis.

Table 3–1 Message Header Fields

Name	Description
`JMSMessageID`	Message identifier
`JMSDestination`	Destination to which message is sent
`JMSReplyTo`	Destination to which to reply
`JMSCorrelationID`	Link to related message
`JMSDeliveryMode`	Delivery mode (persistent or nonpersistent)
`JMSDeliveryTime`	The earliest time a provider may make a message visible on a target destination and available for delivery to consumers.
`JMSPriority`	Priority level
`JMSTimestamp`	Time of transmission
`JMSExpiration`	Expiration time
`JMSType`	Message type
`JMSRedelivered`	Has message been delivered before?

The JMS `Message` interface defines the following methods for setting the corresponding value of each header field. Table 3–2 lists all of the available header specification methods for the JMS `Message` interface.

Table 3–2 JMS 2.0 Message Header Methods for the Message Interface

Name	Description
`setJMSDestination`	Set destination
`setJMSReplyTo`	Set reply destination
`setJMSCorrelationID`	Set correlation identifier from string
`setJMSCorrelationIDAsBytes`	Set correlation identifier from byte array
`setJMSType`	Set message type

The JMS `Producer` interface defines the following methods for setting the corresponding value of each header field. Table 3–3 lists all of the available header specification methods.

Table 3–3 JMS 2.0 Message Header Methods for the Producer Interface

Name	Description
`setJMSMessageID`	Set message identifier
`setJMSDeliveryMode`	Set delivery mode
`setJMSPriority`	Set priority level
`setJMSTimestamp`	Set time stamp
`setJMSExpiration`	Set expiration time
`setJMSRedelivered`	Set redelivered flag
`setJMSDeliveryTime`	Set the delivery time for a message

See the "Java Message Service specification, version 2.0", available from http://jcp.org/en/jsr/detail?id=343 for a more detailed discussion of all message header fields.

Changes for Standard JMS 2.0 Message Properties

The JMS specification defines certain standard properties, listed in Table 3–4. By convention, the names of all such standard properties begin with the letters `JMSX`; names of this form are reserved and must not be used by a client application for its own custom message properties. These properties are not enabled by default, an application must set the name/value pairs it requires on the appropriate connection factory.

The JMS 2.0 specification requires that JMS producers set the `JMSXDeliveryCount`. This property was not supported prior to MQ 5.0.

Table 3–4 Standard JMS 2.0 Message Properties

Name	Type	Required?	Set by	Description
`JMSXUserID`	`String`	Optional	Provider on Send	Identity of user sending message
`JMSXAppID`	`String`	Optional	Provider on Send	Identity of application sending message
`JMSXDeliveryCount`	`int`	Required	Provider on Receive	Number of delivery attempts
`JMSXGroupID`	`String`	Optional	Client	Identity of message group to which this message belongs
`JMSXGroupSeq`	`int`	Optional	Client	Sequence number within message group
`JMSXProducerTXID`	`String`	Optional	Provider on Send	Identifier of transaction within which message was produced
`JMSXConsumerTXID`	`String`	Optional	Provider on Receive	Identifier of transaction within which message was consumed
`JMSXRcvTimestamp`	`long`	Optional	Provider on Receive	Time message delivered to consumer
`JMSXState`	`int`	Optional	Provider	Message state (waiting, ready, expired, or retained)

Sending Messages

In order to send messages to a message broker, you must create a `JMSProducer` object using the `createProducer()` method on `JMSContext`. For example:

```
try (JMSContext context = connectionFactory.createContext();){
context.createProducer().send(inboundQueue,body)
}
```

The JMS 2.0 specification allows a client to specify a delivery delay value, in milliseconds, for each message it sends. This value is used to determine a messages's delivery time which is calculated by adding the delivery delay value specified on the send to the time the message was sent. See Message Headers.

Table 3–5 shows the methods defined in the `JMSProducer` interface.

Table 3–5 JMSProducer Methods

Name	Description
`getDestination`	Get default destination
`setDeliveryMode`	Set default delivery mode
`getDeliveryMode`	Get default delivery mode
`getDeliveryDelay`	Get delivery delay value in milliseconds
`setDeliveryDelay`	Set delivery delay value in milliseconds
`setPriority`	Set default priority level
`getPriority`	Get default priority level
`setTimeToLive`	Set default message lifetime
`getTimeToLive`	Get default message lifetime
`setDisableMessageID`	Set message identifier disable flag
`getDisableMessageID`	Get message identifier disable flag
`setDisableMessageTimestamp`	Set time stamp disable flag
`getDisableMessageTimestamp`	Get time stamp disable flag
`send`	Send message
`close`	Close message producer

Simplified API methods for Asynchronous Sends

In the Simplified API, a JMS provider sends a message asynchronously by calling `setAsync(CompletionListener completionListener)` on the `JMSProducer` prior to calling one of the following `send` methods:

- `send(Destination destination, Message message)`
- `send(Destination destination, String body)`
- `send(Destination destination, Map<String,Object> body)`
- `send(Destination destination, byte[] body)`
- `send(Destination destination, Serializable body)`
- `send(Destination destination, String body)`

Note: These `send` methods are the same as methods that are used for a synchronous send. However, calling `setAsync` beforehand changes their behavior.

For more information on how to convert common synchronous send design patterns to use asynchronous sends, see Asynchronous send.

Receiving Messages

This section provides information on new behaviors and two new subscription types for clients to use when consuming messages.

Using Shared Non-durable Subscriptions

A shared non-durable subscription is used by a client that needs to be able to share the work of receiving messages from a non-durable topic subscription across multiple consumers. Each message from the subscription is delivered to only one of the consumers that may exist on that subscription.

Shared non-durable subscriptions are created and a consumer crated on the subscription using one of the following:

- Classic API: One of the `createSharedConsumer` methods on `Session` which return a `MessageConsumer` object.
- Simplified API: One of the `createSharedConsumer` methods on `JMSContext` which returns a `JMSContext` object.

A shared non-durable subscription exists only as long as there is an active consumer on the subscription. It is identified by name and an optional client identifier (`clientId`). If the client identifier was set when the subscription was created, any client that creates a consumer on that shared non-durable subscription must use the same client identifier. This type of subscription is not persisted and is deleted, along with any undelivered messages, when the last consumer on the subscription is deleted. The `noLocal` parameter is not supported for shared non-durable subscriptions.

Using Shared Durable Subscriptions

A shared durable subscription is used by an application that needs to share the work of receiving all the messaged published on a topic, including messages published when no consumers are associated with the subscription. Each message from the subscription is delivered to only one of the consumers that may exist on that subscription. For this subscription type, the JMS provider ensures all the messages from the topic's publishers:

- Are Delivered and acknowledged or
- Have expired

Shared durable subscriptions are created and a consumer crated on the subscription using one of the following:

- Classic API: One of the `createSharedDurableConsumer` methods on `Session` which return a `MessageConsumer` object.
- Simplified API: One of the `createSharedDurableConsumer` methods on `JMSContext` which returns a `JMSContext` object.

A shared durable e subscription persists and accumulates messages until it is explicitly deleted using the `unsubscribe` method on either `Session` or `JMSContext`. You cannot delete a durable subscription with an active consumer or while a message is received from the subscription is part of a transaction. It is identified by name and an optional client identifier (`clientId`). If the client identifier was set when the subscription was created, any client that creates a consumer on that shared non-durable subscription must use the same client identifier. The `noLocal` parameter is not supported for shared durable subscriptions.

Starting Message Delivery

An application using the Classic API to consume messages needs to call the connection's `start` method to start delivery of incoming messages. It may temporarily suspend delivery by calling `stop`, after which a call to `start` will restart delivery.

The Simplified API provides corresponding `start` and `stop` methods on `JMSContext`. The `start` method is be called automatically when `createConsumer` or `createDurableConsumer` are called on the `JMSContext` object. There is no need for the application to call `start` when the consumer is first established. An application may temporarily suspend delivery by calling `stop`, after which a call to `start` will restart delivery.

In some situations, an application using the Simplified API may need a connection to remain in stopped mode while setup is being completed and not commence message delivery until the `start` method is explicitly called. You can configure this behavior by calling `setAutoStart(false)` on the `JMSContext` prior to calling `createConsumer` or `createDurableConsumer`.

Processing Messages

Processing a message after you have received it may entail examining its header fields, properties, and body.

Retrieving Message Header Fields

The standard JMS message header fields are described in Table 3–4. Table 3–6 shows the methods provided by the JMS `Message` interface for retrieving the values of these fields: for instance, you can obtain a message's reply destination with the statement:

```
Destination replyDest = inMsg.getJMSReplyTo();
```

Table 3–6 Message Header Retrieval Methods

Name	Description
`getJMSMessageID`	Get message identifier
`getJMSDestination`	Get destination
`getJMSReplyTo`	Get reply destination
`getJMSCorrelationID`	Get correlation identifier as string
`getJMSCorrelationIDAsBytes`	Get correlation identifier as byte array
`getJMSDeliveryMode`	Get delivery mode
`getJMSDeliveryTime`	Get the delivery time
`getJMSPriority`	Get priority level
`getJMSTimestamp`	Get time stamp

Table 3–6 (Cont.) Message Header Retrieval Methods

Name	Description
`getJMSExpiration`	Get expiration time
`getJMSType`	Get message type
`getJMSRedelivered`	Get redelivered flag

4 The JMS Classic API

This chapter describes the JMS classic API. The JMS simplified API offers the same functionality using a simpler implementation and is described in The JMS Simplified API.

The topics covered include the following:

- Messaging Domains
- Working With Connections
- Working With Destinations
- Working With Sessions
- Working With Messages
- Using the Autocloseable Interface

This chapter does not provide exhaustive information about each class and method. For detailed reference information, see the JavaDoc documentation for each individual class. For information on the practical design of Message Queue Java programs, see Message Queue Clients: Design and Features.

Messaging Domains

The Java Message Service (JMS) specification, which Message Queue implements, supports two commonly used models of interaction between message clients and message brokers, sometimes known as *messaging domains:*

- In the *point-to-point* (or *PTP*) messaging model, each message is delivered from a message producer to a single message consumer. The producer delivers the message to a *queue,* from which it is later delivered to one of the consumers registered for the queue. Any number of producers and consumers can interact with the same queue, but each message is guaranteed to be delivered to (and be successfully consumed by) exactly one consumer and no more. If no consumers are registered for a queue, it holds the messages it receives and eventually delivers them when a consumer registers.
- In the *publish/subscribe* (or *pub/sub*) model, a single message can be delivered from a producer to any number of consumers. The producer *publishes* the message to a *topic,* from which it is then delivered to all active consumers that have *subscribed* to the topic. Any number of producers can publish messages to a given topic, and each message can be delivered to any number of subscribed consumers. The model also supports the notion of *durable subscriptions,* in which a consumer registered with a topic need not be active at the time a message is published; when the consumer subsequently becomes active, it will receive the message. If no active

consumers are registered for a topic, the topic does not hold the messages it receives unless it has inactive consumers with durable subscriptions.

JMS applications are free to use either of these messaging models, or even to mix them both within the same application. Historically, the JMS API provided a separate set of domain-specific object classes for each model. While these domain-specific interfaces continue to be supported for legacy purposes, client programmers are now encouraged to use the newer *unified domain* interface, which supports both models indiscriminately. For this reason, the discussions and code examples in this manual focus exclusively on the unified interfaces wherever possible. Table 2–1 shows the API classes for all domains.

Working With Connections

All messaging occurs within the context of a *connection*. Connections are created using a *connection factory* encapsulating all of the needed configuration properties for connecting to a particular JMS provider. A connection's configuration properties are completely determined by the connection factory, and cannot be changed once the connection has been created. Thus the only way to control the properties of a connection is by setting those of the connection factory you use to create it.

Obtaining a Connection Factory

Typically, a connection factory is created for you by a Message Queue administrator and preconfigured, using the administration tools described in "Administrative Tasks and Tools" in *Open Message Queue Administration Guide* with whatever property settings are appropriate for connecting to particular JMS provider. The factory is then placed in a publicly available *administered object store*, where you can access it by name using the Java Naming and Directory Interface (JNDI) API. This arrangement has several benefits:

- It allows the administrator to control the properties of client connections to the provider, ensuring that they are properly configured.
- It enables the administrator to tune performance and improve throughput by adjusting configuration settings even after an application has been deployed.
- By relying on the predefined connection factory to handle the configuration details, it helps keep client code provider-independent and thus more easily portable from one JMS provider to another.

Sometimes, however, it may be more convenient to dispense with JNDI lookup and simply create your own connection factory by direct instantiation. Although hard-coding configuration values for a particular JMS provider directly into your application code sacrifices flexibility and provider-independence, this approach might make sense in some circumstances: for example, in the early stages of application development and debugging, or in applications where reconfigurability and portability to other providers are not important concerns.

The following sections describe these two approaches to obtaining a connection factory: by JNDI lookup or direct instantiation.

Looking Up a Connection Factory With JNDI

Example 4–1 shows how to look up a connection factory object in the JNDI object store. The code example is explained in the procedure that follows.

Note: If a Message Queue client is a Java EE component, JNDI resources are provided by the Java EE container. In such cases, JNDI lookup code may differ from that shown here; see your Java EE provider documentation for details.

Example 4–1 Looking Up a Connection Factory

```
//  Create the environment for constructing the initial JNDI
//  naming context.

    Hashtable  env = new Hashtable();


//  Store the environment attributes that tell JNDI which initial context
//  factory to use  and where to find the provider.//

    env.put(Context.INITIAL_CONTEXT_FACTORY,
                    "com.sun.jndi.fscontext.RefFSContextFactory");
    env.put(Context.PROVIDER_URL, "file:///C:/imq_admin_objects");


//  Create the initial context.

    Context  ctx = new InitialContext(env);


//  Look up the connection factory object in the JNDI object store.

    String  CF_LOOKUP_NAME = "MyConnectionFactory";
    ConnectionFactory  myFactory = (ConnectionFactory) ctx.lookup
                                       (CF_LOOKUP_NAME);
```

To Look Up a Connection Factory With JNDI Follow this procedure:

1. Create the environment for constructing the initial JNDI naming context.

   How you create the initial context depends on whether you are using a file-system object store or a Lightweight Directory Access Protocol (LDAP) server for your Message Queue administered objects. The code shown here assumes a file-system store; for information about the corresponding LDAP object store attributes, see "Using an LDAP User Repository" in *Open Message Queue Administration Guide*.

   The constructor for the initial context accepts an environment parameter, a hash table whose entries specify the attributes for creating the context:

   ```
   Hashtable env = new Hashtable();
   ```

   You can also set an environment by specifying system properties on the command line, rather than programmatically. For instructions, see the `README` file in the JMS example applications directory.

2. Store the environment attributes that tell JNDI which initial context factory to use and where to find the JMS provider.

   The names of these attributes are defined as static constants in class `Context`:

   ```
   env.put(Context.INITIAL_CONTEXT_FACTORY,
   ```

```
        "com.sun.jndi.fscontext.RefFSContextFactory");
env.put(Context.PROVIDER_URL, "file:///C:/imq_admin_objects");
```

Note: The directory represented by `C:/`*imq_admin_objects* must already exist; if necessary, you must create the directory before referencing it in your code.

3. Create the initial context.

   ```
   Context ctx = new InitialContext(env);
   ```

   If you use system properties to set the environment, omit the environment parameter when creating the context:

   ```
   Context ctx = new InitialContext();
   ```

4. Look up the connection factory object in the administered object store and typecast it to the appropriate class:

   ```
   String CF_LOOKUP_NAME = "MyConnectionFactory";
   ConnectionFactory
         myFactory = (ConnectionFactory) ctx.lookup(CF_LOOKUP_NAME);
   ```

   The lookup name you use, `CF_LOOKUP_NAME`, must match the name used when the object was stored.

   You can now proceed to use the connection factory to create connections to the message broker, as described under Using Connections.

Overriding Configuration Settings

It is recommended that you use a connection factory just as you receive it from a JNDI lookup, with the property settings originally configured by your Message Queue administrator. However, there may be times when you need to override the preconfigured properties with different values of your own. You can do this from within your application code by calling the connection factory's `setProperty` method. This method (inherited from the superclass `AdministeredObject`) takes two string arguments giving the name and value of the property to be set. The property names for the first argument are defined as static constants in the Message Queue class `ConnectionConfiguration`: for instance, the statement

```
myFactory.setProperty(ConnectionConfiguration.imqDefaultPassword,
                      "mellon");
```

sets the default password for establishing broker connections. See "Connection Factory Attributes" in *Open Message Queue Administration Guide* for complete information on the available connection factory configuration attributes.

It is also possible to override connection factory properties from the command line, by using the `-D` option to set their values when starting your client application. For example, the command line

```
java -DimqDefaultPassword=mellon MyMQClient
```

starts an application named `MyMQClient` with the same default password as in the preceding example. Setting a property value this way overrides any other value specified for it, whether preconfigured in the JNDI object store or set programmatically with the `setProperty` method.

Note: A Message Queue administrator can prevent a connection factory's properties from being overridden by specifying that the object be read-only when placing it in the object store. The properties of such a factory cannot be changed in any way, whether with the `-D` option from the command line or using the `setProperty` method from within your client application's code. Any attempt to override the factory's property values will simply be ignored.

Instantiating a Connection Factory

Example 4–2 shows how to create a connection factory object by direct instantiation and configure its properties.

Example 4–2 Instantiating a Connection Factory

```
//  Instantiate the connection factory object.

    com.sun.messaging.ConnectionFactory
        myFactory = new com.sun.messaging.ConnectionFactory();


//  Set the connection factory's configuration properties.

    myFactory.setProperty(ConnectionConfiguration.imqAddressList,
                          "localhost:7676,broker2:5000,broker3:9999");
```

The following procedure explains each program statement in the previous code sample.

To Instantiate and Configure a Connection Factory Follow this procedure:

1. Instantiate the connection factory object.

   The name `ConnectionFactory` is defined both as a JMS interface (in package `javax.jms`) and as a Message Queue class (in `com.sun.messaging`) that implements that interface. Since only a class can be instantiated, you must use the constructor defined in `com.sun.messaging` to create your connection factory object. Note, however, that you cannot import the name from both packages without causing a compilation error. Hence, if you have imported the entire package `javax.jms.*`, you must qualify the constructor with the full package name when instantiating the object:

   ```
   com.sun.messaging.ConnectionFactory
       myFactory = new com.sun.messaging.ConnectionFactory();
   ```

   Notice that the type declaration for the variable `myFactory`, to which the instantiated connection factory is assigned, is also qualified with the full package name. This is because the `setProperty` method, used in Instantiating a Connection Factory, belongs to the `ConnectionFactory` class defined in the package `com.sun.messaging`, rather than to the `ConnectionFactory` interface defined in `javax.jms` . Thus in order for the compiler to recognize this method, `myFactory` must be typed explicitly as `com.sun.messaging.ConnectionFactory` rather than simply `ConnectionFactory` (which would resolve to `javax.jms.ConnectionFactory` after importing `javax.jms.*`).

2. Set the connection factory's configuration properties.

   The most important configuration property is `imqAddressList`, which specifies the host names and port numbers of the message brokers to which the factory creates connections. By default, the factory returned by the `ConnectionFactory` constructor in Instantiating a Connection Factory is configured to create connections to a broker on host `localhost` at port number `7676`. If necessary, you can use the `setProperty` method, described in the preceding section, to change that setting:

   ```
   myFactory.setProperty(ConnectionConfiguration.imqAddressList,
                         "localhost:7676,broker2:5000,broker3:9999");
   ```

   When specifying the host name portion of a broker, you can use a literal IPv4 or IPv6 address instead of a host name. If you use a literal IPv6 address, its format must conform to RFC2732 (`http://www.ietf.org/rfc/rfc2732.txt`), *Format for Literal IPv6 Addresses in URL's*.

   Of course, you can also set any other configuration properties your application may require. See "Connection Factory Attributes" in *Open Message Queue Administration Guide* for a list of the available connection factory attributes.

   You can now proceed to use the connection factory to create connections to the message service, as described in the next section.

Using Connections

Once you have obtained a connection factory, you can use it to create a connection to the message service. The factory's `createConnection` method takes a user name and password as arguments:

```
Connection
      myConnection = myFactory.createConnection("mithrandir", "mellon");
```

Before granting the connection, Message Queue authenticates the user name and password by looking them up in its user repository. As a convenience for developers who do not wish to go to the trouble of populating a user repository during application development and testing, there is also a parameterless form of the `createConnection` method:

```
Connection myConnection = myFactory.createConnection();
```

This creates a connection configured for the default user identity, with both user name and password set to `guest`.

This unified-domain `createConnection` method is part of the generic JMS `ConnectionFactory` interface, defined in package `javax.jms`; the Message Queue version in `com.sun.messaging` adds corresponding methods `createQueueConnection` and `createTopicConnection` for use specifically with the point-to-point and publish/subscribe domains.

The following table shows the methods defined in the `Connection` interface.

Table 4–1 Connection Methods

Name	Description
`createSession`	Create session
`setClientID`	Set client identifier
`getClientID`	Get client identifier

Table 4–1 (Cont.) Connection Methods

Name	Description
`setEeventListener`	Set event listener for connection events
`setExceptionListener`	Set exception listener
`getExceptionListener`	Get exception listener
`getMetaData`	Get metadata for connection
`createConnectionConsumer`	Create connection consumer
`createDurableConnectionConsumer`	Create durable connection consumer
`start`	Start incoming message delivery
`stop`	Stop incoming message delivery
`close`	Close connection

The main purpose of a connection is to create *sessions* for exchanging messages with the message service:

```
myConnection.createSession(false, Session.AUTO_ACKNOWLEDGE);
```

The first argument to `createSession` is a boolean indicating whether the session is transacted; the second specifies its acknowledgment mode. Possible values for this second argument are `AUTO_ACKNOWLEDGE`, `CLIENT_ACKNOWLEDGE`, and `DUPS_OK_ACKNOWLEDGE`, all defined as static constants in the standard JMS `Session` interface, `javax.jms.Session` ; the extended Message Queue version of the interface, `com.sun.messaging.jms.Session` , adds another such constant, `NO_ACKNOWLEDGE`. See Acknowledgment Modes and Transacted Sessions for further discussion.

If your client application will be using the publish/subscribe domain to create durable topic subscriptions, it must have a *client identifier* to identify itself to the message service. In general, the most convenient arrangement is to configure the client runtime to provide a unique client identifier automatically for each client. However, the `Connection` interface also provides a method, `setClientID`, for setting a client identifier explicitly, and a corresponding `getClientID` method for retrieving its value. See Assigning Client Identifiers in this guide and "Client Identifier" in *Open Message Queue Administration Guide* for more information.

You should also use the `setExceptionListener` method to register an *exception listener* for the connection. This is an object implementing the JMS `ExceptionListener` interface, which consists of the single method `onException`:

```
void onException (JMSException exception)
```

In the event of a problem with the connection, the message broker will call this method, passing an exception object identifying the nature of the problem.

A connection's `getMetaData` method returns a `ConnectionMetaData` object, which in turn provides methods for obtaining various items of information about the connection, such as its JMS version and the name and version of the JMS provider.

The `createConnectionConsumer` and `createDurableConnectionConsumer` methods (as well as the session methods `setMessageListener` and `getMessageListener`, listed in Table 4–2) are used for concurrent message consumption; see the *Java Message Service Specification* for more information.

In order to receive incoming messages, you must 7*start* the connection by calling its `start` method:

```
myConnection.start();
```

It is important not to do this until after you have created any message consumers you will be using to receive messages on the connection. Starting the connection before creating the consumers risks missing some incoming messages before the consumers are ready to receive them. It is not necessary to start the connection in order to send outgoing messages.

If for any reason you need to suspend the flow of incoming messages, you can do so by calling the connection's `stop` method:

```
myConnection.stop();
```

To resume delivery of incoming messages, call the `start` method again.

Finally, when you are through with a connection, you should *close* it to release any resources associated with it:

```
myConnection.close();
```

This automatically closes all sessions, message producers, and message consumers associated with the connection and deletes any temporary destinations. All pending message receives are terminated and any transactions in progress are rolled back. Closing a connection does *not* force an acknowledgment of client-acknowledged sessions.

Creating Secure Connections (SSL)

A connection service that is based on the Transport Layer Security (TLS/SSL) standard is used to authenticate and encrypt messages sent between the client and the broker. This section describes what the client needs to do to use TLS/SSL connections. A user can also establish a secure connection by way of an HTTPS tunnel servlet. For information on setting up secure connections over HTTP, see "HTTP/HTTPS Support" in *Open Message Queue Administration Guide*.

Some of the work needed to set up a TLS/SSL connection is done by an administrator. This section summarizes these steps. For complete information about the administrative work required, please see "Message Encryption" in *Open Message Queue Administration Guide*.

To set up a secure connection service, you must do the following.

1. Generate a self-signed or signed certificate for the broker (administrator).
2. Enable the `ssljms` connection service in the broker (administrator).
3. Start the broker (administrator).
4. Configure and run the client as explained below.

To configure a client to use a TLS/SSL connection you must do the following.

1. If your client is not using J2SDK 1.4 (which has JSSE and JNDI support built in), make sure the client has the following files in its class path:`jsse.jar`, `jnet.jar`, `jcert, jar`,`jndi.jar`.
2. Make sure the client has the following Message Queue files in its class path: `imq.jar`,`jms.jar`.
3. If the client is not willing to trust the broker's self-signed certificate, set the `imqSSLIsHostTrusted` attribute to false for the connection factory from which you get the TLS/SSL connection.

4. Connect to the broker's `ssljms` service. There are two ways to do this. The first is to specify the service name `ssljms` in the address for the broker when you provide a value for the `imqAddressList` attribute of the connection factory from which you obtain the connection. When you run the client, it will be connected to the broker by a TLS/SSLconnection. The second is to specify the following directive when you run the command that starts the client.

   ```
   java -DimqConnectionType=TLS clientAppName
   ```

Working With Destinations

All Message Queue messages travel from a message producer to a message consumer by way of a *destination* on a message broker. Message delivery is thus a two-stage process: the message is first delivered from the producer to the destination and later from the destination to the consumer. Physical destinations on the broker are created administratively by a Message Queue administrator, using the administration tools described in "Configuring and Managing Physical Destinations" in *Open Message Queue Administration Guide*. The broker provides routing and delivery services for messages sent to such a destination.

As described earlier under Messaging Domains, Message Queue supports two types of destination, depending on the messaging domain being used:

- Queues (point-to-point domain)
- Topics (publish/subscribe domain)

These two types of destination are represented by the Message Queue classes `Queue` and `Topic`, respectively. These, in turn, are both subclasses of the generic class `Destination`. A client program that uses the `Destination` superclass can thus handle both queue and topic destinations indiscriminately.

Looking Up a Destination With JNDI

Because JMS providers differ in their destination addressing conventions, Message Queue does not define a standard address syntax for obtaining access to a destination. Rather, the destination is typically placed in a publicly available administered object store by a Message Queue administrator and accessed by the client using a JNDI lookup in a manner similar to that described earlier for connection factories (see Looking Up a Connection Factory With JNDI).

Example 4–3 shows how to look up a destination object in the JNDI object store.

Note: If a Message Queue client is a Java EE component, JNDI resources are provided by the Java EE container. In such cases, JNDI lookup code may differ from that shown here; see your Java EE provider documentation for details.

Example 4–3 Looking Up a Destination

```
//  Create the environment for constructing the initial JNDI naming context.

    Hashtable env = new Hashtable();


//  Store the environment attributes that tell JNDI which initial
//  context factory to use and where to find the provider.
```

```
    env.put(Context.INITIAL_CONTEXT_FACTORY,
                    "com.sun.jndi.fscontext.RefFSContextFactory");
    env.put(Context.PROVIDER_URL, "file:///C:/imq_admin_objects");


//  Create the initial context.

    Context  ctx = new InitialContext(env);


//  Look up the destination object in the JNDI object store.

    String  DEST_LOOKUP_NAME = "MyDest";
    Destination  MyDest = (Destination) ctx.lookup(DEST_LOOKUP_NAME);
```

The following section explains the program statements in Example 4–3.

To Look Up a Destination With JNDI

1. Create the environment for constructing the initial JNDI naming context.

   How you create the initial context depends on whether you are using a file-system object store or a Lightweight Directory Access Protocol (LDAP) server for your Message Queue administered objects. The code shown here assumes a file-system store; for information about the corresponding LDAP object store attributes, see "LDAP Server Object Stores" in *Open Message Queue Administration Guide*.

   The constructor for the initial context accepts an environment parameter, a hash table whose entries specify the attributes for creating the context:

   ```
   Hashtable env = new Hashtable();
   ```

   You can also set an environment by specifying system properties on the command line, rather than programmatically. For instructions, see the `README` file in the JMS example applications directory.

2. Store the environment attributes that tell JNDI which initial context factory to use and where to find the JMS provider.

   The names of these attributes are defined as static constants in class `Context`:

   ```
   env.put(Context.INITIAL_CONTEXT_FACTORY,
           "com.sun.jndi.fscontext.RefFSContextFactory");
   env.put(Context.PROVIDER_URL, "file:///C:/imq_admin_objects");
   ```

   > **Note:** The directory represented by `C:/`*imq_admin_objects* must already exist; if necessary, you must create the directory before referencing it in your code.

3. Create the initial context.

   ```
   Context ctx = new InitialContext(env);
   ```

   If you use system properties to set the environment, omit the environment parameter when creating the context:

```
Context ctx = new InitialContext();
```

4. Look up the destination object in the administered object store and typecast it to the appropriate class:

   ```
   String DEST_LOOKUP_NAME = "MyDest";
   Destination MyDest = (Destination) ctx.lookup(DEST_LOOKUP_NAME);
   ```

   The lookup name you use, `DEST_LOOKUP_NAME`, must match the name used when the object was stored. Note that the actual destination object returned from the object store will always be either a (point-to-point) queue or a (publish/subscribe) topic, but that either can be assigned to a variable of the generic unified-domain class `Destination`.

   Note: For topic destinations, a symbolic lookup name that includes wildcard characters can be used as the lookup string. Wildcard characters can only be used to match topic names and are not supported in JNDI names. See "Supported Topic Destination Names" in *Open Message Queue Administration Guide*.

   You can now proceed to send and receive messages using the destination, as described under Sending Messages and Receiving Messages.

Instantiating a Destination

As with connection factories, you may sometimes find it more convenient to dispense with JNDI lookup and simply create your own queue or topic destination objects by direct instantiation. Although a variable of type `Destination` can accept objects of either class, you cannot directly instantiate a `Destination` object; the object must always belong to one of the specific classes `Queue` or `Topic`. The constructors for both of these classes accept a string argument specifying the name of the physical destination to which the object corresponds:

```
Destination myDest = new com.sun.messaging.Queue("myDest");
```

Note, however, that this only creates a Java object representing the destination; it does *not* actually create a physical destination on the message broker. The physical destination itself must still be created by a Message Queue administrator, with the same name you pass to the constructor when instantiating the object.

Note: Destination names beginning with the letters `mq` are reserved and should not be used by client programs.

Also, for topic destinations, a symbolic lookup name that includes wildcard characters can be used as the lookup string. See "Supported Topic Destination Names" in *Open Message Queue Administration Guide*.

Unlike connection factories, destinations have a much more limited set of configuration properties. In fact, only two such properties are defined in the Message Queue class `DestinationConfiguration`: the name of the physical destination itself (`imqDestinationName`) and an optional descriptive string (`imqDestinationDescription`). Since the latter property is rarely used and the physical destination name can be supplied directly as an argument to the `Queue` or `Topic` constructor as shown above, there normally is no need (as there often is with a connection factory) to specify additional properties with the object's `setProperty` method. Hence the variable to which you assign the destination object (`myDest` in the example above) need not be typed with the Message Queue class `com.sun.messaging.Destination`; the standard JMS interface `javax.jms.Destination` (which the Message Queue class implements) is sufficient. If you have imported the full JMS package `javax.jms.*`, you can simply declare the variable with the unqualified name `Destination`, as above, rather than with something like

```
com.sun.messaging.Destination
    myDest = new com.sun.messaging.Queue("myDest");
```

as shown earlier for connection factories.

Temporary Destinations

A *temporary destination* is one that exists only for the duration of the connection that created it. You may sometimes find it convenient to create such a destination to use, for example, as a reply destination for messages you send. Temporary destinations are created with the session method `createTemporaryQueue` or `createTemporaryTopic` (see Working With Sessions below): for example,

```
TemporaryQueue tempQueue = mySession.createTemporaryQueue();
```

Although the temporary destination is created by a particular session, its scope is actually the entire connection to which that session belongs. Any of the connection's sessions (not just the one that created the temporary destination) can create a message consumer for the destination and receive messages from it. The temporary destination is automatically deleted when its connection is closed, or you can delete it explicitly by calling its `delete` method:

```
tempQueue.delete();
```

Working With Sessions

A *session* is a single-threaded context for producing and consuming messages. You can create multiple message producers and consumers for a single session, but you are restricted to using them serially, in a single logical thread of control.

Table 4–2 shows the methods defined in the `Session` interface; they are discussed in the relevant sections below.

Table 4–2 Session Methods

Name	Description
`createProducer`	Create message producer
`createConsumer`	Create message consumer
`createDurableSubscriber`	Create durable subscriber for topic
`unsubscribe`	Delete durable subscription to topic
`createMessage`	Create null message
`createTextMessage`	Create text message
`createStreamMessage`	Create stream message
`createMapMessage`	Create map message
`createObjectMessage`	Create object message

Table 4–2 (Cont.) Session Methods

Name	Description
`createBytesMessage`	Create bytes message
`createQueue`	Create queue destination
`createTopic`	Create topic destination
`createTemporaryQueue`	Create temporary queue
`createTemporaryTopic`	Create temporary topic
`createBrowser`	Create message browser
`setMessageListener`	Set distinguished message listener
`getMessageListener`	Get distinguished message listener
`getAcknowledgeMode`	Get session's acknowledgment mode
`getTransacted`	Is session transacted?
`commit`	Commit transaction
`rollback`	Roll back transaction
`recover`	Recover unacknowledged messages
`close`	Close session

Every session exists within the context of a particular connection. The number of sessions you can create for a single connection is limited only by system resources. As described earlier (see Using Connections), you use the connection's `createSession` method to create a session:

```
Session
   mySession = myConnection.createSession(false, Session.AUTO_ACKNOWLEDGE);
```

The first (boolean) argument specifies whether the session is transacted; see Transacted Sessions for further discussion. The second argument is an integer constant representing the session's acknowledgment mode, as described in the next section.

Acknowledgment Modes

A session's *acknowledgment mode* determines the way your application handles the exchange of acknowledgment information when receiving messages from a broker. The JMS specification defines three possible acknowledgment modes:

- In *auto-acknowledge mode,* the Message Queue client runtime immediately sends a *client acknowledgment* for each message it delivers to the message consumer; it then blocks waiting for a return *broker acknowledgment* confirming that the broker has received the client acknowledgment. This acknowledgment "handshake" between client and broker is handled automatically by the client runtime, with no need for explicit action on your part.
- In *client-acknowledge mode,* your client application must explicitly acknowledge the receipt of all messages. This allows you to defer acknowledgment until after you have finished processing the message, ensuring that the broker will not delete it from persistent storage before processing is complete. You can either acknowledge each message individually or batch multiple messages and acknowledge them all at once; the client acknowledgment you send to the broker applies to all messages received since the previous acknowledgment. In either case, as in auto-acknowledge mode, the session thread blocks after sending the client

acknowledgment, waiting for a broker acknowledgment in return to confirm that your client acknowledgment has been received.

- In *dups-OK-acknowledge mode,* the session automatically sends a client acknowledgment each time it has received a fixed number of messages, or when a fixed time interval has elapsed since the last acknowledgment was sent. (This fixed batch size and timeout interval are currently 10 messages and 7 seconds, respectively, and are not configurable by the client.) Unlike the first two modes described above, the broker does *not* acknowledge receipt of the client acknowledgment, and the session thread does not block awaiting such return acknowledgment from the broker. This means that you have no way to confirm that your acknowledgment has been received; if it is lost in transmission, the broker may redeliver the same message more than once. However, because client acknowledgments are batched and the session thread does not block, applications that can tolerate multiple delivery of the same message can achieve higher throughput in this mode than in auto-acknowledge or client-acknowledge mode.

  Message Queue extends the JMS specification by adding a fourth acknowledgment mode:

- In *no-acknowledge mode,* your client application does not acknowledge receipt of messages, nor does the broker expect any such acknowledgment. There is thus no guarantee whatsoever that any message sent by the broker has been successfully received. This mode sacrifices all reliability for the sake of maximum throughput of message traffic.

The standard JMS `Session` interface, defined in package `javax.jms`, defines static constants for the first three acknowledgment modes (`AUTO_ACKNOWLEDGE`, `CLIENT_ACKNOWLEDGE`, and `DUPS_OK_ACKNOWLEDGE`), to be used as arguments to the connection's `createSession` method. The constant representing the fourth mode (`NO_ACKNOWLEDGE`) is defined in the extended Message Queue version of the interface, in package `com.sun.messaging.jms`. The session method `getAcknowledgeMode` returns one of these constants:

```
int ackMode = mySession.getAcknowledgeMode();
switch (ackMode)
  {
    case Session.AUTO_ACKNOWLEDGE:
      /* Code here to handle auto-acknowledge mode */
      break;
    case Session.CLIENT_ACKNOWLEDGE:
      /* Code here to handle client-acknowledge mode */
      break;
    case Session.DUPS_OK_ACKNOWLEDGE:
      /* Code here to handle dups-OK-acknowledge mode */
      break;
    case com.sun.messaging.jms.Session.NO_ACKNOWLEDGE:
      /* Code here to handle no-acknowledge mode */
      break;
  }
```

Note: All of the acknowledgment modes discussed above apply to message consumption. For message production, the broker's acknowledgment behavior depends on the message's delivery mode (persistent or nonpersistent; see Message Header). The broker acknowledges the receipt of persistent messages, but not of nonpersistent ones; this behavior is not configurable by the client.

In a transacted session (see next section), the acknowledgment mode is ignored and all acknowledgment processing is handled for you automatically by the Message Queue client runtime. In this case, the `getAcknowledgeMode` method returns the special constant `Session.SESSION_TRANSACTED`.

Transacted Sessions

Transactions allow you to group together an entire series of incoming and outgoing messages and treat them as an atomic unit. The message broker tracks the state of the transaction's individual messages, but does not complete their delivery until you *commit* the transaction. In the event of failure, you can *roll back* the transaction, canceling all of its messages and restarting the entire series from the beginning.

Transactions always take place within the context of a single session. To use them, you must create a *transacted session* by passing `true` as the first argument to a connection's `createSession` method:

```
Session
   mySession = myConnection.createSession(true, Session.SESSION_TRANSACTED);
```

The session's `getTransacted` method tests whether it is a transacted session:

```
if ( mySession.getTransacted() )
  { /* Code here to handle transacted session */
  }
else
  { /* Code here to handle non-transacted session */
  }
```

A transacted session always has exactly one open transaction, encompassing all messages sent or received since the session was created or the previous transaction was completed. Committing or rolling back a transaction ends that transaction and automatically begins another.

Note: Because the scope of a transaction is limited to a single session, it is not possible to combine the production and consumption of a message into a single end-to-end transaction. That is, the delivery of a message from a message producer to a destination on the broker cannot be placed in the same transaction with its subsequent delivery from the destination to a consumer.

When all messages in a transaction have been successfully delivered, you call the session's `commit` method to commit the transaction:

```
mySession.commit();
```

All of the session's incoming messages are acknowledged and all of its outgoing messages are sent. The transaction is then considered complete and a new one is started.

When a send or receive operation fails, an exception is thrown. While it is possible to handle the exception by simply ignoring it or by retrying the operation, it is recommended that you roll back the transaction, using the session's `rollback` method:

```
mySession.rollback();
```

All of the session's incoming messages are recovered and redelivered, and its outgoing messages are destroyed and must be re-sent.

Working With Messages

This section describes how to use the Message Queue Java API to compose, send, receive, and process messages.

Message Structure

A message consists of the following parts:

- A *header* containing identifying and routing information
- Optional *properties* that can be used to convey additional identifying information beyond that contained in the header
- A *body* containing the actual content of the message

The following sections discuss each of these in greater detail.

Message Header

Every message must have a *header* containing identifying and routing information. The header consists of a set of standard fields, which are defined in the *Java Message Service Specification* and summarized in Table 4–3. Some of these are set automatically by Message Queue in the course of producing and delivering a message, some depend on settings specified when a message producer sends a message, and others are set by the client on a message-by-message basis.

Table 4–3 Message Header Fields

Name	Description
`JMSMessageID`	Message identifier
`JMSDestination`	Destination to which message is sent
`JMSReplyTo`	Destination to which to reply
`JMSCorrelationID`	Link to related message
`JMSDeliveryMode`	Delivery mode (persistent or nonpersistent)
`JMSDeliveryTime`	The earliest time a provider may make a message visible on a target destination and available for delivery to consumers.
`JMSPriority`	Priority level
`JMSTimestamp`	Time of transmission
`JMSExpiration`	Expiration time
`JMSType`	Message type
`JMSRedelivered`	Has message been delivered before?

The JMS `Message` interface defines methods for setting the value of each header field: for instance,

```
outMsg.setJMSReplyTo(replyDest);
```

Table 4–4 lists all of the available header specification methods.

Table 4–4 Message Header Specification Methods

Name	Description
`setJMSMessageID`	Set message identifier

Table 4–4 (Cont.) Message Header Specification Methods

Name	Description
`setJMSDestination`	Set destination
`setJMSReplyTo`	Set reply destination
`setJMSCorrelationID`	Set correlation identifier from string
`setJMSCorrelationIDAsBytes`	Set correlation identifier from byte array
`setJMSDeliveryMode`	Set delivery mode
`setJMSPriority`	Set priority level
`setJMSTimestamp`	Set time stamp
`setJMSExpiration`	Set expiration time
`setJMSType`	Set message type
`setJMSRedelivered`	Set redelivered flag

The *message identifier* (`JMSMessageID`) is a string value uniquely identifying the message, assigned and set by the message broker when the message is sent. Because generating an identifier for each message adds to both the size of the message and the overhead involved in sending it, and because some client applications may not use them, the JMS interface provides a way to suppress the generation of message identifiers, using the message producer method `setDisableMessageID` (see Sending Messages).

The `JMSDestination` header field holds a `Destination` object representing the destination to which the message is directed, set by the message broker when the message is sent. There is also a `JMSReplyTo` field that you can set to specify a destination to which reply messages should be directed. Clients sending such a reply message can set its `JMSCorrelationID` header field to refer to the message to which they are replying. Typically this field is set to the message identifier string of the message being replied to, but client applications are free to substitute their own correlation conventions instead, using either the `setJMSCorrelationID` method (if the field value is a string) or the more general `setJMSCorrelationIDAsBytes` (if it is not).

The *delivery mode* (`JMSDeliveryMode`) specifies whether the message broker should log the message to stable storage. There are two possible values, `PERSISTENT` and `NON_PERSISTENT`, both defined as static constants of the JMS interface `DeliveryMode`: for example,

```
outMsg.setJMSDeliveryMode(DeliveryMode.NON_PERSISTENT);
```

The default delivery mode is `PERSISTENT`, represented by the static constant `Message.DEFAULT_DELIVERY_MODE`.

The choice of delivery mode represents a tradeoff between performance and reliability:

- In *persistent mode,* the broker logs the message to stable storage, ensuring that it will not be lost in transit in the event of transmission failure; the message is guaranteed to be delivered exactly once.
- In *nonpersistent mode,* the message is not logged to stable storage; it will be delivered at most once, but may be lost in case of failure and not delivered at all. This mode does, however, improve performance by reducing the broker's message-handling overhead. It may thus be appropriate for applications in which performance is at a premium and reliability is not.

The message's priority level (JMSPriority) is expressed as an integer from 0 (lowest) to 9 (highest). Priorities from 0 to 4 are considered gradations of normal priority, those from 5 to 9 of expedited priority. The default priority level is 4, represented by the static constant Message.DEFAULT_PRIORITY.

The Message Queue client runtime sets the JMSTimestamp header field to the time it delivers the message to the broker, expressed as a long integer in standard Java format (milliseconds since midnight, January 1, 1970 UTC). The message's lifetime, specified when the message is sent, is added to this value and the result is stored in the JMSExpiration header field. (The default lifetime value of 0, represented by the static constant Message.DEFAULT_TIME_TO_LIVE, denotes an unlimited lifetime. In this case, the expiration time is also set to 0 to indicate that the message never expires.) As with the message identifier, client applications that do not use a message's time stamp can improve performance by suppressing its generation with the message producer method setDisableMessageTimestamp (see Sending Messages).

The header field JMSType can contain an optional message type identifier string supplied by the client when the message is sent. This field is intended for use with other JMS providers; Message Queue clients can simply ignore it.

When a message already delivered must be delivered again because of a failure, the broker indicates this by setting the JMSRedelivered flag in the message header to true. This can happen, for instance, when a session is recovered or a transaction is rolled back. The receiving client can check this flag to avoid duplicate processing of the same message (such as when the message has already been successfully received but the client's acknowledgment was missed by the broker).

See the *Java Message Service Specification* for a more detailed discussion of all message header fields.

Message Properties

A *message property* consists of a name string and an associated value, which must be either a string or one of the standard Java primitive data types (int, byte, short, long, float, double, or boolean). The Message interface provides methods for setting properties of each type (see Table 4–5). There is also a setObjectProperty method that accepts a primitive value in objectified form, as a Java object of class Integer, Byte, Short, Long, Float , Double, Boolean, or String . The clearProperties method deletes all properties associated with a message; the message header and body are not affected.

Table 4–5 Message Property Specification Methods

Name	Description
setIntProperty	Set integer property
setByteProperty	Set byte property
setShortProperty	Set short integer property
setLongProperty	Set long integer property
setFloatProperty	Set floating-point property
setDoubleProperty	Set double-precision property
setBooleanProperty	Set boolean property
setStringProperty	Set string property
setObjectProperty	Set property from object
clearProperties	Clear properties

The JMS specification defines certain standard properties, listed in Table 4–6. By convention, the names of all such standard properties begin with the letters `JMSX`; names of this form are reserved and must not be used by a client application for its own custom message properties. These properties are not enabled by default, an application must set the name/value pairs it requires on the appropriate connection factory.

Table 4–6 Standard JMS Message Properties

Name	Type	Required?	Description
`JMSXUserID`	`String`	Optional	Identity of user sending message
`JMSXAppID`	`String`	Optional	Identity of application sending message
`JMSXDeliveryCount`	`int`	Optional	Number of delivery attempts
`JMSXGroupID`	`String`	Optional	Identity of message group to which this message belongs
`JMSXGroupSeq`	`int`	Optional	Sequence number within message group
`JMSXProducerTXID`	`String`	Optional	Identifier of transaction within which message was produced
`JMSXConsumerTXID`	`String`	Optional	Identifier of transaction within which message was consumed
`JMSXRcvTimestamp`	`long`	Optional	Time message delivered to consumer
`JMSXState`	`int`	Optional	Message state (waiting, ready, expired, or retained)

Message Body

The actual content of a message is contained in the *message body.* JMS defines six classes (or types) of message, each with a different body format:

- A *text message* (interface `TextMessage`) contains a Java string.
- A *stream message* (interface `StreamMessage`) contains a stream of Java primitive values, written and read sequentially.
- A *map message* (interface `MapMessage`) contains a set of name-value pairs, where each name is a string and each value is a Java primitive value. The order of the entries is undefined; they can be accessed randomly by name or enumerated sequentially.
- An *object message* (interface `ObjectMessage`) contains a serialized Java object (which may in turn be a collection of other objects).
- A *bytes message* (interface `BytesMessage`) contains a stream of uninterpreted bytes.
- A *null message* (interface `Message`) consists of a header and properties only, with no message body.

Each of these is a subinterface of the generic `Message` interface, extended with additional methods specific to the particular message type.

Composing Messages

The JMS `Session` interface provides methods for creating each type of message, as shown in Table 4–7. For instance, you can create a text message with a statement such as

```
TextMessage outMsg = mySession.createTextMessage();
```

In general, these methods create a message with an empty body; the interfaces for specific message types then provide additional methods for filling the body with content, as described in the sections that follow.

Table 4–7 Session Methods for Message Creation

Name	Description
`createMessage`	Create null message
`createTextMessage`	Create text message
`createStreamMessage`	Create stream message
`createMapMessage`	Create map message
`createObjectMessage`	Create object message
`createBytesMessage`	Create bytes message

Note: Some of the message-creation methods have an overloaded form that allows you to initialize the message body directly at creation: for example,

```
TextMessage
   outMsg = mySession.createTextMessage("Hello, World!");
```

These exceptions are pointed out in the relevant sections below.

Once a message has been delivered to a message consumer, its body is considered read-only; any attempt by the consumer to modify the message body will cause an exception (`MessageNotWriteableException`) to be thrown. The consumer can, however, empty the message body and place it in a writeable state by calling the message method `clearBody`:

```
outMsg.clearBody();
```

This places the message in the same state as if it had been newly created, ready to fill its body with new content.

Composing Text Messages

You create a text message with the session method `createTextMessage`. You can either initialize the message body directly at creation time

```
TextMessage outMsg = mySession.createTextMessage("Hello, World!");
```

or simply create an empty message and then use its `setText` method (see Table 4–8) to set its content:

```
TextMessage outMsg = mySession.createTextMessage();
outMsg.setText("Hello, World!");
```

Table 4–8 Text Message Composition Method

Name	Description
`setText`	Set content string

Composing Stream Messages

The session method `createStreamMessage` returns a new, empty stream message. You can then use the methods shown in Table 4–9 to write primitive data values into the message body, similarly to writing to a data stream: for example,

```
StreamMessage outMsg = mySession.createStreamMessage();
outMsg.writeString("The Meaning of Life");
outMsg.writeInt(42);
```

Table 4–9 Stream Message Composition Methods

Name	Description
`writeInt`	Write integer to message stream
`writeByte`	Write byte value to message stream
`writeBytes`	Write byte array to message stream
`writeShort`	Write short integer to message stream
`writeLong`	Write long integer to message stream
`writeFloat`	Write floating-point value to message stream
`writeDouble`	Write double-precision value to message stream
`writeBoolean`	Write boolean value to message stream
`writeChar`	Write character to message stream
`writeString`	Write string to message stream
`writeObject`	Write value of object to message stream
`reset`	Reset message stream

As a convenience for handling values whose types are not known until execution time, the `writeObject` method accepts a string or an objectified primitive value of class `Integer`, `Byte`, `Short`, `Long`, `Float`, `Double` , `Boolean`, or `Character` and writes the corresponding string or primitive value to the message stream: for example, the statements

```
Integer meaningOfLife = new Integer(42);
outMsg.writeObject(meaningOfLife);
```

are equivalent to

```
outMsg.writeInt(42);
```

This method will throw an exception (`MessageFormatException`) if the argument given to it is not of class `String` or one of the objectified primitive classes.

Once you've written the entire message contents to the stream, the `reset` method

```
outMsg.reset();
```

puts the message body in read-only mode and repositions the stream to the beginning, ready to read (see Processing Messages). When the message is in this state, any attempt to write to the message stream will throw the exception `MessageNotWriteableException`. A call to the `clearBody` method (inherited from the superinterface `Message`) deletes the entire message body and makes it writeable again.

Composing Map Messages

Table 4–10 shows the methods available in the `MapMessage` interface for adding content to the body of a map message. Each of these methods takes two arguments, a name string and a primitive or string value of the appropriate type, and adds the corresponding name-value pair to the message body: for example,

```
StreamMessage outMsg = mySession.createMapMessage();
outMsg.setInt("The Meaning of Life", 42);
```

Table 4–10 Map Message Composition Methods

Name	Description
`setInt`	Store integer in message map by name
`setByte`	Store byte value in message map by name
`setBytes`	Store byte array in message map by name
`setShort`	Store short integer in message map by name
`setLong`	Store long integer in message map by name
`setFloat`	Store floating-point value in message map by name
`setDouble`	Store double-precision value in message map by name
`setBoolean`	Store boolean value in message map by name
`setChar`	Store character in message map by name
`setString`	Store string in message map by name
`setObject`	Store object in message map by name

Like stream messages, map messages provide a convenience method (`setObject`) for dealing with values whose type is determined dynamically at execution time: for example, the statements

```
Integer meaningOfLife = new Integer(42);
outMsg.setObject("The Meaning of Life", meaningOfLife);
```

are equivalent to

```
outMsg.setInt("The Meaning of Life", 42);
```

The object supplied must be either a string object (class `String`) or an objectified primitive value of class `Integer`, `Byte` , `Short`, `Long`, `Float`, `Double`, `Boolean`, or `Character`; otherwise an exception (`MessageFormatException`) will be thrown.

Composing Object Messages

The `ObjectMessage` interface provides just one method, `setObject` (Table 4–11), for setting the body of an object message:

```
ObjectMessage outMsg = mySession.createObjectMessage();
outMsg.setObject(bodyObject);
```

The argument to this method can be any serializable object (that is, an instance of any class that implements the standard Java interface `Serializable`). If the object is not serializable, the exception `MessageFormatException` will be thrown.

Table 4–11 Object Message Composition Method

Name	Description
`setObject`	Serialize object to message body

As an alternative, you can initialize the message body directly when you create the message, by passing an object to the session method `createObjectMessage`:

```
ObjectMessage outMsg = mySession.createObjectMessage(bodyObject);
```

Again, an exception will be thrown if the object is not serializable.

Composing Bytes Messages

The body of a bytes message simply consists of a stream of uninterpreted bytes; its interpretation is entirely a matter of agreement between sender and receiver. This type of message is intended primarily for encoding message formats required by other existing message systems; Message Queue clients should generally use one of the other, more specific message types instead.

Composing a bytes message is similar to composing a stream message (see Composing Stream Messages). You create the message with the session method `createBytesMessage`, then use the methods shown in Table 4–12 to encode primitive values into the message's byte stream: for example,

```
BytesMessage outMsg = mySession.createBytesMessage();
outMsg.writeUTF("The Meaning of Life");
outMsg.writeInt(42);
```

Table 4–12 Bytes Message Composition Methods

Name	Description
`writeInt`	Write integer to message stream
`writeByte`	Write byte value to message stream
`writeBytes`	Write byte array to message stream
`writeShort`	Write short integer to message stream
`writeLong`	Write long integer to message stream
`writeFloat`	Write floating-point value to message stream
`writeDouble`	Write double-precision value to message stream
`writeBoolean`	Write boolean value to message stream
`writeChar`	Write character to message stream
`writeUTF`	Write UTF-8 string to message stream
`writeObject`	Write value of object to message stream
`reset`	Reset message stream

As with stream and map messages, you can use the generic object-based method `writeObject` to handle values whose type is unknown at compilation time: for example, the statements

```
Integer meaningOfLife = new Integer(42);
outMsg.writeObject(meaningOfLife);
```

are equivalent to

```
outMsg.writeInt(42);
```

The message's `reset` method

```
outMsg.reset();
```

puts the message body in read-only mode and repositions the byte stream to the beginning, ready to read (see Processing Messages). Attempting to write further content to a message in this state will cause an exception (`MessageNotWriteableException`). The inherited `Message` method `clearBody` can be used to delete the entire message body and make it writeable again.

Sending Messages

In order to send messages to a message broker, you must create a *message producer* using the session method `createProducer`:

```
MessageProducer myProducer = mySession.createProducer(myDest);
```

The scope of the message producer is limited to the session that created it and the connection to which that session belongs. Table 4–13 shows the methods defined in the `MessageProducer` interface.

Table 4–13 Message Producer Methods

Name	Description
`getDestination`	Get default destination
`setDeliveryMode`	Set default delivery mode
`getDeliveryMode`	Get default delivery mode
`setPriority`	Set default priority level
`getPriority`	Get default priority level
`setTimeToLive`	Set default message lifetime
`getTimeToLive`	Get default message lifetime
`setDisableMessageID`	Set message identifier disable flag
`getDisableMessageID`	Get message identifier disable flag
`setDisableMessageTimestamp`	Set time stamp disable flag
`getDisableMessageTimestamp`	Get time stamp disable flag
`send`	Send message
`close`	Close message producer

The `createProducer` method takes a destination as an argument, which may be either a (point-to-point) queue or a (publish/subscribe) topic. The producer will then send all of its messages to the specified destination. If the destination is a queue, the producer is called a *sender* for that queue; if it is a topic, the producer is a *publisher to that topic.* The message producer's `getDestination` method returns this destination.

You also have the option of leaving the destination unspecified when you create a producer

```
MessageProducer myProducer = mySession.createProducer(null);
```

in which case you must specify an explicit destination for each message. This option is typically used for producers that must send messages to a variety of destinations, such as those designated in the `JMSReplyTo` header fields of incoming messages (see Message Header).

Note: The generic `MessageProducer` interface also has specialized subinterfaces, `QueueSender` and `TopicPublisher`, for sending messages specifically to a point-to-point queue or a publish/subscribe topic. These types of producer are created by the `createSender` and `createPublisher` methods of the specialized session subinterfaces `QueueSession` and `TopicSession`, respectively. However, it is generally more convenient (and recommended) to use the generic form of message producer described here, which can handle both types of destination indiscriminately.

A producer has a default delivery mode (persistent or nonpersistent), priority level, and message lifetime, which it will apply to all messages it sends unless explicitly overridden for an individual message. You can set these properties with the message producer methods `setDeliveryMode`, `setPriority`, and `setTimeToLive`, and retrieve them with `getDeliveryMode`, `getPriority`, and `getTimeToLive`. If you don't set them explicitly, they default to persistent delivery, priority level `4`, and a lifetime value of `0`, denoting an unlimited message lifetime.

The heart of the message producer interface is the `send` method, which is available in a variety of overloaded forms. The simplest of these just takes a message as its only argument:

```
myProducer.send(outMsg);
```

This sends the specified message to the producer's default destination, using the producer's default delivery mode, priority, and message lifetime. Alternatively, you can explicitly specify the destination

```
myProducer.send(myDest, outMsg);
```

or the delivery mode, priority, and lifetime in milliseconds

```
myProducer.send(outMsg, DeliveryMode.NON_PERSISTENT, 9, 1000);
```

or all of these at once:

```
myProducer.send(myDest, outMsg, DeliveryMode.NON_PERSISTENT, 9, 1000);
```

Recall that if you did not specify a destination when creating the message producer, you must provide an explicit destination for each message you send.

As discussed earlier under Message Header, client applications that have no need for the message identifier and time stamp fields in the message header can gain some performance improvement by suppressing the generation of these fields, using the message producer's `setDisableMessageID` and `setdisableMessageTimestamp` methods. Note that a `true` value for either of these flags *disables* the generation of the corresponding header field, while a `false` value enables it. Both flags are set to `false` by default, meaning that the broker will generate the values of these header fields unless explicitly instructed otherwise.

When you are finished using a message producer, you should call its `close` method

```
myProducer.close();
```

allowing the broker and client runtime to release any resources they may have allocated on the producer's behalf.

Asynchronous send

The JMS 2.0 specification allows clients to send a message asynchronously. This permits the JMS provider to perform part of the work involved in sending the message in a separate thread.

When a message has been successfully sent, the JMS provider invokes the callback method `onCompletion` on an application-specified `CompletionListener` object. Only when that callback has been invoked can the application be sure that the message has been successfully sent with the same degree of confidence as if a synchronous send had been performed. An application which requires this degree of confidence must wait for the callback to be invoked before continuing.

The following section provides guidelines on how to convert two common synchronous send design patterns to use asynchronous sends.

- A producer sends messages using a synchronous send to a remote JMS server and then waits for an acknowledgement to be received before returning.

  A producer implements an asynchronous send by sending the message to the remote JMS server and then returning without waiting for an acknowledgement. When the acknowledgement is received, the JMS provider would notify the application by invoking the `onCompletion` method on the application-specified `CompletionListener` object. If for some reason the acknowledgement is not received, the JMS provider would notify the application by invoking `CompletionListener.onException`.
- A producer sends messages using a synchronous send to a remote JMS server and does not wait for an acknowledgement to be received before returning.

  A producer implements an asynchronous send by sending the message to the remote JMS server and then return without waiting for an acknowledgement. The JMS provider then notifies the application that the send had completed by invoking the `onCompletion` method on the application-specified `CompletionListener` object.

Methods for Asynchronous Sends IA JMS provider uses `MessageProducer` to send a message asynchronously using one of the following:

- `send(Message message, CompletionListener completionListener)`
- `send(Message message, int deliveryMode, int priority, long timeToLive, CompletionListener completionListener)`
- `send(Destination destination, Message message, CompletionListener completionListener)`
- `send(Destination destination, Message message, int deliveryMode, int priority, long timeToLive, CompletionListener completionListener)`

Receiving Messages

Messages are received by a *message consumer,* within the context of a connection and a session. Once you have created a consumer, you can use it to receive messages in either of two ways:

- In *synchronous* message consumption, you explicitly request the delivery of messages when you are ready to receive them.
- In *asynchronous* message consumption, you register a *message listener* for the consumer. The Message Queue client runtime then calls the listener whenever it has a message to deliver.

These two forms of message consumption are described in the sections Receiving Messages Synchronously and Receiving Messages Asynchronously.

Creating Message Consumers

The session method `createConsumer` creates a generic consumer that can be used to receive messages from either a (point-to-point) queue or a (publish/subscribe) topic:

```
MessageConsumer myConsumer = mySession.createConsumer(myDest);
```

If the destination is a queue, the consumer is called a *receiver* for that queue; if it is a topic, the consumer is a *subscriber to that topic.*

Note: The generic `MessageConsumer` interface also has specialized subinterfaces, `QueueReceiver` and `TopicSubscriber`, for receiving messages specifically from a point-to-point queue or a publish/subscribe topic. These types of consumer are created by the `createReceiver` and `createSubscriber` methods of the specialized session subinterfaces `QueueSession` and `TopicSession`, respectively. However, it is generally more convenient (and recommended) to use the generic form of message consumer described here, which can handle both types of destination indiscriminately.

A subscriber created for a topic destination with the `createConsumer` method is always *nondurable*, meaning that it will receive only messages that are sent *(published)*to the topic while the subscriber is active. If you want the broker to retain messages published to a topic while no subscriber is active and deliver them when one becomes active again, you must instead create a *durable subscriber,* as described in Durable Subscribers.

Table 4–14 shows the methods defined in the `MessageConsumer` interface, which are discussed in detail in the relevant sections below.

Table 4–14 Message Consumer Methods

Name	Description
`getMessageSelector`	Get message selector
`receive`	Receive message synchronously
`receiveNoWait`	Receive message synchronously without blocking
`setMessageListener`	Set message listener for asynchronous reception
`getMessageListener`	Get message listener for asynchronous reception

Table 4–14 (Cont.) Message Consumer Methods

Name	Description
`close`	Close message consumer

Message Selectors If appropriate, you can restrict the messages a consumer will receive from its destination by supplying a *message selector* as an argument when you create the consumer:

```
String mySelector = "/* Text of selector here */";
MessageConsumer myConsumer = mySession.createConsumer(myDest, mySelector);
```

The selector is a string whose syntax is based on a subset of the SQL92 conditional expression syntax, which allows you to filter the messages you receive based on the values of their properties (see Message Properties). See the *Java Message Service Specification* for a complete description of this syntax. The message consumer's `getMessageSelector` method returns the consumer's selector string (or `null` if no selector was specified when the consumer was created):

```
String mySelector = myConsumer.getMessageSelector();
```

Note: Messages whose properties do not satisfy the consumer's selector will be retained undelivered by the destination until they are retrieved by another message consumer. The use of message selectors can thus cause messages to be delivered out of sequence from the order in which they were originally produced. Only a message consumer without a selector is guaranteed to receive messages in their original order.

In some cases, the same connection may both publish and subscribe to the same topic destination. The `createConsumer` method accepts an optional boolean argument that suppresses the delivery of messages published by the consumer's own connection:

```
String mySelector = "/* Text of selector here */";
MessageConsumer
        myConsumer = mySession.createConsumer(myDest, mySelector, true);
```

The resulting consumer will receive only messages published by a different connection.

Durable Subscribers To receive messages delivered to a publish/subscribe topic while no message consumer is active, you must ask the message broker to create a *durable subscriber* for that topic. All sessions that create such subscribers for a given topic must have the same client identifier (see Using Connections). When you create a durable subscriber, you supply a subscriber name that must be unique for that client identifier:

```
MessageConsumer
        myConsumer = mySession.createDurableSubscriber(myDest, "mySub");
```

(The object returned by the `createDurableSubscriber` method is actually typed as `TopicSubscriber`, but since that is a subinterface of `MessageConsumer`, you can safely assign it to a `MessageConsumer` variable. Note, however, that the destination `myDest` must be a publish/subscribe topic and not a point-to-point queue.)

You can think of a durable subscriber as a "virtual message consumer" for the specified topic, identified by the unique combination of a client identifier and subscriber name.

When a message arrives for the topic and no message consumer is currently active for it, the message will be retained for later delivery. Whenever you create a consumer with the given client identifier and subscriber name, it will be considered to represent this same durable subscriber and will receive all of the accumulated messages that have arrived for the topic in the subscriber's absence. Each message is retained until it is delivered to (and acknowledged by) such a consumer or until it expires.

Note: Only one session at a time can have an active consumer for a given durable subscription. If another such consumer already exists, the `createDurableSubscriber` method will throw an exception.

Like the `createConsumer` method described in the preceding section (which creates nondurable subscribers), `createDurableSubscriber` can accept an optional message selector string and a boolean argument telling whether to suppress the delivery of messages published by the subscriber's own connection:

```
String mySelector = "/* Text of selector here */";
MessageConsumer myConsumer
                    = mySession.createDurableSubscriber(myDest, "mySub",
                                                        mySelector, true);
```

You can change the terms of a durable subscription by creating a new subscriber with the same client identifier and subscription name but with a different topic, selector, or both. The effect is as if the old subscription were destroyed and a new one created with the same name. When you no longer need a durable subscription, you can destroy it with the session method `unsubscribe`:

```
mySession.unsubscribe("mySub");
```

Receiving Messages Synchronously

Once you have created a message consumer for a session, using either the `createConsumer` or`createDurableSubscriber` method, you must *start* the session's connection to begin the flow of incoming messages:

```
myConnection.start();
```

(Note that it is not necessary to start a connection in order to produce messages, only to consume them.) You can then use the consumer's `receive` method to receive messages synchronously from the message broker:

```
Message inMsg = myConsumer.receive();
```

This returns the next available message for this consumer. If no message is immediately available, the `receive` method blocks until one arrives. You can also provide a timeout interval in milliseconds:

```
Message inMsg = myConsumer.receive(1000);
```

In this case, if no message arrives before the specified timeout interval (1 second in the example) expires, the method will return with a null result. An alternative method, `receiveNoWait`, returns a null result immediately if no message is currently available:

```
Message inMsg = myConsumer.receiveNoWait();
```

Receiving Messages Asynchronously

If you want your message consumer to receive incoming messages asynchronously, you must create a *message listener* to process the messages. This is a Java object that implements the JMS `MessageListener` interface. The procedure is as follows:

To Set Up a Message Queue Java Client to Receive Messages Asynchronously Follow this procedure:

1. Define a message listener class implementing the `MessageListener` interface.

   The interface consists of the single method `onMessage`, which accepts a message as a parameter and processes it in whatever way is appropriate for your application:

   ```
   public class MyMessageListener implements MessageListener
     {
         public void onMessage (Message inMsg)
         {
           /* Code here to process message */
         }
      }
   ```

2. Create a message consumer.

   You can use either the `createConsumer` or `createDurableSubscriber` method of the session in which the consumer will operate: for instance,

   ```
   MessageConsumer myConsumer = mySession.createConsumer(myDest);
   ```

3. Create an instance of your message listener class.

   ```
   MyMessageListener myListener = new MyMessageListener();
   ```

4. Associate the message listener with your message consumer.

   The message consumer method `setMessageListener` accepts a message listener object and associates it with the given consumer:

   ```
   myConsumer.setMessageListener(myListener);
   ```

5. Start the connection to which this consumer's session belongs.

   The connection's `start` method begins the flow of messages from the message broker to your message consumer:

   ```
   myConnection.start();
   ```

   Once the connection is started, the Message Queue client runtime will call your message listener's `onMessage` method each time it has a message to deliver to this consumer.

   To ensure that no messages are lost before your consumer is ready to receive them, it is important not to start the connection until after you have created the message listener and associated it with the consumer. If the connection is already started, you should stop it before creating an asynchronous consumer, then start it again when the consumer is ready to begin processing.

   Setting a consumer's message listener to `null` removes any message listener previously associated with it:

   ```
   myConsumer.setMessageListener(null);
   ```

   The consumer's `getMessageListener` method returns its current message listener (or `null` if there is none):

```
MyMessageListener myListener = myConsumer.getMessageListener();
```

Acknowledging Messages

If you have specified client-acknowledge as your session's acknowledgment mode (see Acknowledgment Modes), it is your client application's responsibility to explicitly acknowledge each message it receives. If you have received the message synchronously, using a message consumer's `receive` (or `receiveNoWait`) method, you should process the message first and then acknowledge it; if you have received it asynchronously, your message listener's `onMessage` method should acknowledge the message after processing it. This ensures that the message broker will not delete the message from persistent storage until processing is complete.

Note: In a transacted session (see Transacted Sessions), there is no need to acknowledge a message explicitly: the session's acknowledgment mode is ignored and all acknowledgment processing is handled for you automatically by the Message Queue client runtime. In this case, the session's `getAcknowledgeMode` method will return the special constant `Session.SESSION_TRANSACTED`.

Table 4–15 shows the methods available for acknowledging a message. The most general is `acknowledge`, defined in the standard JMS interface `javax.jms.Message`:

```
inMsg.acknowledge();
```

This acknowledges all unacknowledged messages consumed by the session up to the time of call. You can use this method to acknowledge each message individually as you receive it, or you can group several messages together and acknowledge them all at once by calling `acknowledge` on the last one in the group.

Table 4–15 Message Acknowledgment Methods

Function	Description
`acknowledge`	Acknowledge all unacknowledged messages for session
`acknowledgeThisMessage`	Acknowledge this message only
`acknowledgeUpThroughThisMessage`	Acknowledge all unacknowledged messages through this one

The Message Queue version of the `Message` interface, defined in the package `com.sun.messaging.jms`, adds two more methods that provide more flexible control over which messages you acknowledge. The `acknowledgeThisMessage` method just acknowledges the single message for which it is called, rather than all messages consumed by the session; `acknowledgeUpThroughThisMessage` acknowledges the message for which it is called and all previous messages; messages received after that message remain unacknowledged.

Browsing Messages

If the destination from which you are consuming messages is a point-to-point queue, you can use a *queue browser* to examine the messages in the queue without consuming them. The session method `createBrowser` creates a browser for a specified queue:

```
QueueBrowser myBrowser = mySession.createBrowser(myDest);
```

The method will throw an exception (`InvalidDestinationException`) if you try to pass it a topic destination instead of a queue. You can also supply a selector string as an optional second argument:

```
String        mySelector = "/* Text of selector here */";
QueueBrowser  myBrowser  = mySession.createBrowser(myDest, mySelector);
```

Table 4–16 shows the methods defined in the `QueueBrowser` interface. The `getQueue` and `getMessageSelector` methods return the browser's queue and selector string, respectively.

Table 4–16 Queue Browser Methods

Name	Description
`getQueue`	Get queue from which this browser reads
`getMessageSelector`	Get message selector
`getEnumeration`	Get enumeration of all messages in the queue
`close`	Close browser

The most important queue browser method is `getEnumeration`, which returns a Java enumeration object that you can use to iterate through the messages in the queue, as shown in Example 4–4.

Example 4–4 Browsing a Queue

```
Enumeration  queueMessages = myBrowser.getEnumeration();
Message      eachMessage;

while ( queueMessages.hasMoreElements() )
  { eachMessage = queueMessages.nextElement();
    /* Do something with the message */
  }
```

The browser's `close` method closes it when you're through with it:

```
myBrowser.close();
```

Closing a Consumer

As a matter of good programming practice, you should *close* a message consumer when you have no further need for it. Closing a session or connection automatically closes all consumers associated with it; to close a consumer without closing the session or connection to which it belongs, you can use its `close` method:

```
myConsumer.close();
```

For a consumer that is a nondurable topic subscriber, this terminates the flow of messages to the consumer. However, if the consumer is a queue receiver or a durable topic subscriber, messages will continue to be accumulated for the destination and will be delivered the next time a consumer for that destination becomes active. To terminate a durable subscription permanently, call its session's `unsubscribe` method with the subscriber name as an argument:

```
mySession.unsubscribe("mySub");
```

Processing Messages

Processing a message after you have received it may entail examining its header fields, properties, and body. The following sections describe how this is done.

Retrieving Message Header Fields

The standard JMS message header fields are described in Table 4–3. Table 4–17 shows the methods provided by the JMS `Message` interface for retrieving the values of these fields: for instance, you can obtain a message's reply destination with the statement

```
Destination replyDest = inMsg.getJMSReplyTo();
```

Table 4–17 Message Header Retrieval Methods

Name	Description
`getJMSMessageID`	Get message identifier
`getJMSDestination`	Get destination
`getJMSReplyTo`	Get reply destination
`getJMSCorrelationID`	Get correlation identifier as string
`getJMSCorrelationIDAsBytes`	Get correlation identifier as byte array
`getJMSDeliveryMode`	Get delivery mode
`getJMSPriority`	Get priority level
`getJMSTimestamp`	Get time stamp
`getJMSExpiration`	Get expiration time
`getJMSType`	Get message type
`getJMSRedelivered`	Get redelivered flag

Retrieving Message Properties

Table 4–18 lists the methods defined in the JMS `Message` interface for retrieving the values of a message's properties (see Message Properties). There is a retrieval method for each of the possible primitive types that a property value can assume: for instance, you can obtain a message's time stamp with the statement

```
long  timeStamp = inMsg.getLongProperty("JMSXRcvTimestamp");
```

Table 4–18 Message Property Retrieval Methods

Name	Description
`getIntProperty`	Get integer property
`getByteProperty`	Get byte property
`getShortProperty`	Get short integer property
`getLongProperty`	Get long integer property
`getFloatProperty`	Get floating-point property
`getDoubleProperty`	Get double-precision property
`getBooleanProperty`	Get boolean property
`getStringProperty`	Get string property

Table 4–18 (Cont.) Message Property Retrieval Methods

Name	Description
`getObjectProperty`	Get property as object
`getPropertyNames`	Get property names
`propertyExists`	Does property exist?

There is also a generic `getObjectProperty` method that returns a property value in objectified form, as a Java object of class `Integer`, `Byte`, `Short`, `Long`, `Float` , `Double`, `Boolean`, or `String` . For example, another way to obtain a message's time stamp, equivalent to that shown above, would be

```
Long  timeStampObject = (Long)inMsg.getObjectProperty("JMSXRcvTimestamp");
long  timeStamp = timeStampObject.longValue();
```

If the message has no property with the requested name, `getObjectProperty` will return `null`; the message method `propertyExists` tests whether this is the case.

The `getPropertyNames` method returns a Java enumeration object for iterating through all of the property names associated with a given message; you can then use the retrieval methods shown in the table to retrieve each of the properties by name, as shown in Example 4–5.

Example 4–5 Enumerating Message Properties

```
Enumeration  propNames = inMsg.getPropertyNames();
String       eachName;
Object       eachValue;

while ( propNames.hasMoreElements() )
  { eachName  = propNames.nextElement();
    eachValue = inMsg.getObjectProperty(eachName);
    /* Do something with the value */
  }
```

Processing the Message Body

The methods for retrieving the contents of a message's body essentially parallel those for composing the body, as described earlier under Composing Messages. The following sections describe these methods for each of the possible message types (text, stream, map, object, and bytes).

Processing Text Messages The text message method `getText` (Table 4–19) retrieves the contents of a text message's body in the form of a string:

```
String textBody = inMsg.getText();
```

Table 4–19 Text Message Access Method

Name	Description
`getText`	Get content string

Processing Stream Messages Reading the contents of a stream message is similar to reading from a data stream, using the access methods shown in Table 4–20: for example, the statement

```
int intVal = inMsg.readInt();
```

retrieves an integer value from the message stream.

Table 4–20 Stream Message Access Methods

Name	Description
`readInt`	Read integer from message stream
`readByte`	Read byte value from message stream
`readBytes`	Read byte array from message stream
`readShort`	Read short integer from message stream
`readLong`	Read long integer from message stream
`readFloat`	Read floating-point value from message stream
`readDouble`	Read double-precision value from message stream
`readBoolean`	Read boolean value from message stream
`readChar`	Read character from message stream
`readString`	Read string from message stream
`readObject`	Read value from message stream as object

The `readObject` method returns the next value from the message stream in objectified form, as a Java object of the class corresponding to the value's primitive data type: for instance, if the value is of type `int`, `readObject` returns an object of class `Integer`. The following statements are equivalent to the one shown above:

```
Integer  intObject = (Integer) inMsg.readObject();
int      intVal    = intObject.intValue();
```

Processing Map Messages The `MapMessage` interface provides the methods shown in Table 4–21 for reading the body of a map message. Each access method takes a name string as an argument and returns the value to which that name is mapped: for instance, under the example shown in Composing Map Messages, the statement

```
int meaningOfLife = inMsg.getInt("The Meaning of Life");
```

would set the variable `meaningOfLife` to the value `42`.

Table 4–21 Map Message Access Methods

Name	Description
`getInt`	Get integer from message map by name
`getByte`	Get byte value from message map by name
`getBytes`	Get byte array from message map by name
`getShort`	Get short integer from message map by name
`getLong`	Get long integer from message map by name
`getFloat`	Get floating-point value from message map by name
`getDouble`	Get double-precision value from message map by name
`getBoolean`	Get boolean value from message map by name
`getChar`	Get character from message map by name

Table 4–21 (Cont.) Map Message Access Methods

Name	Description
`getString`	Get string from message map by name
`getObject`	Get object from message map by name
`itemExists`	Does map contain an item with specified name?
`getMapNames`	Get enumeration of all names in map

Like stream messages, map messages provide an access method, `getObject`, that returns a value from the map in objectified form, as a Java object of the class corresponding to the value's primitive data type: for instance, if the value is of type `int`, `getObject` returns an object of class `Integer`. The following statements are equivalent to the one shown above:

```
Integer  meaningObject = (Integer) inMsg.getObject("The Meaning of Life");
int      meaningOfLife = meaningObject.intValue();
```

The `itemExists` method returns a boolean value indicating whether the message map contains an association for a given name string:

```
if ( inMsg.itemExists("The Meaning of Life") )
  { /* Life is meaningful */
  }
else
  { /* Life is meaningless */
  }
```

The `getMapNames` method returns a Java enumeration object for iterating through all of the names defined in the map; you can then use `getObject` to retrieve the corresponding values, as shown in Example 4–6.

Example 4–6 Enumerating Map Message Values

```
Enumeration  mapNames = inMsg.getMapNames();
String       eachName;
Object       eachValue;

while ( mapNames.hasMoreElements() )
  { eachName  = mapNames.nextElement();
    eachValue = inMsg.getObject(eachName);
    /* Do something with the value */
  }
```

Processing Object Messages The `ObjectMessage` interface provides just one method, `getObject` (Table 4–22), for retrieving the serialized object that is the body of an object message:

```
Object messageBody = inMsg.getObject();
```

You can then typecast the result to a more specific class and process it in whatever way is appropriate.

Table 4–22 Object Message Access Method

Name	Description
`getObject`	Get serialized object from message body

Processing Bytes Messages The body of a bytes message simply consists of a stream of uninterpreted bytes; its interpretation is entirely a matter of agreement between sender and receiver. This type of message is intended primarily for decoding message formats used by other existing message systems; Message Queue clients should generally use one of the other, more specific message types instead.

Reading the body of a bytes message is similar to reading a stream message (see Processing Stream Messages): you use the methods shown in Table 4–23 to decode primitive values from the message's byte stream. For example, the statement

```
int intVal = inMsg.readInt();
```

retrieves an integer value from the byte stream. The `getBodyLength` method returns the length of the entire message body in bytes:

```
int bodyLength = inMsg.getBodyLength();
```

Table 4–23 Bytes Message Access Methods

Name	Description
`getBodyLength`	Get length of message body in bytes
`readInt`	Read integer from message stream
`readByte`	Read signed byte value from message stream
`readUnsignedByte`	Read unsigned byte value from message stream
`readBytes`	Read byte array from message stream
`readShort`	Read signed short integer from message stream
`readUnsignedShort`	Read unsigned short integer from message stream
`readLong`	Read long integer from message stream
`readFloat`	Read floating-point value from message stream
`readDouble`	Read double-precision value from message stream
`readBoolean`	Read boolean value from message stream
`readChar`	Read character from message stream
`readUTF`	Read UTF-8 string from message stream

Simplified Extraction of Message Bodies

You can use the `getBody` method to provide a convenient way to obtain the body from a newly-received `Message` object. Use `getBody` to:

- Return the body of a `TextMessage`, `MapMessage`, or `BytesMessage` as a `String`, `Map`, or `byte[]` without the need to cast the `Message` first to the appropriate subtype.
- Return the body of an `ObjectMessage` without the need to cast the `Message` to `ObjectMessage`, extract the body as a `Serializable`, and cast it to the specified type.

The `isBodyAssignableTo` method can be used to determine whether a subsequent call to `getBody` would be able to return the body of a particular `Message` object as a particular type.

Using the Autocloseable Interface

Objects from interfaces that extend the `java.lang.Autocloseable` and use a `try-with-resources` statement do not need to explicitly call `close()` when these objects are no longer required.

The following interfaces extend the `java.lang.Autocloseable` interface:

- `Connection`
- `Session`
- `MessageProducer`
- `MessageConsumer`
- `QueueBrowser`

For example:

```
. . .
try (Connection connection = connectionFactory.createConnection();){
   // use connection in this try block
   // it will be closed when try block completes
} catch (JMSException e){
   // exception handling
}
. . .
```

5 Using the Metrics Monitoring API

Message Queue provides several ways of obtaining metrics data as a means of monitoring and tuning performance. One of these methods, message-based monitoring, allows metrics data to be accessed programmatically and then to be processed in whatever way suits the consuming client. Using this method, a client subscribes to one or more metrics destinations and then consumes and processes messages produced by the broker to those destinations. Message-based monitoring is the most customized solution to metrics gathering, but it does require the effort of writing a consuming client that retrieves and processes metrics messages.

The methods for obtaining metrics data are described in "Monitoring Broker Operations" in *Open Message Queue Administration Guide*, which also discusses the relative merits of each method and the set of data that is captured by each. Before you decide to used message-based monitoring, you should consult this guide to make sure that you will be able to obtain the information you need using this method.

Message-based monitoring is enabled by the combined efforts of administrators and programmers. The administrator is responsible for configuring the broker so that it produces the messages of interest at a specified interval and that it persists these messages for a set time. The programmer is responsible for selecting the data to be produced and for creating the client that will consume and process the data.

This chapter focuses on the work the programmer must do to implement a message-based monitoring client. It includes the following sections:

- Monitoring Overview
- Creating a Metrics-Monitoring Client
- Format of Metrics Messages
- Metrics Monitoring Client Code Examples

Monitoring Overview

Message Queue includes an internal client that is enabled by default to produce different types of metrics messages. Production is actually enabled when a client subscribes to a topic destination whose name matches one of the metrics message types. For example, if a client subscribes to the topic `mq.metrics.jvm`, the client receives information about JMV memory usage.

The metrics topic destinations (metric message types) are described in Table 5–1.

Table 5–1 Metrics Topic Destinations

Topic Destination Name	Type of Metrics Messages
`mq.metrics.broker`	Broker metrics: information on connections, message flow, and volume of messages in the broker.
`mq.metrics.jvm`	Java Virtual Machine metrics: information on memory usage in the JVM.
`mq.metrics.destination_list`	A list of all destinations on the broker, and their types.
`mq.metrics.destination.queue.`*dn*	Destination metrics for a queue of the specified name. Metrics data includes number of consumers, message flow or volume, disk usage, and more. Specify the destination name for the *dn* variable.
`mq.metrics.destination.topic.`*dn*	Destination metrics for a topic of the specified name. Metrics data includes number of consumers, message flow or volume, disk usage, and more. Specify the destination name for the *dn* variable.

A metrics message that is produced to one of the destinations listed in Table 5–1 is a normal JMS message; its header and body are defined to hold the following information:

- The message header has several properties, one that specifies the metrics message type, one that records the time the message was produced (timestamp), and a collection of properties identifying the broker that sent the metric message (broker host, port, and address/URL).
- The message body contains name-value pairs that vary with the message type.

  The section Format of Metrics Messages provides complete information about the types of metrics messages and their content (name-value pairs).

To receive metrics messages, the consuming client must be subscribed to the destination of interest. Otherwise, consuming a metrics message is exactly the same as consuming any JMS message. The message can be consumed synchronously or asynchronously, and then processed as needed by the client.

Message-based monitoring is concerned solely with obtaining metrics information. It does not include methods that you can call to work with physical destinations, configure or update the broker, or shutdown and restart the broker.

Administrative Tasks

By default the Message Queue metrics-message producing client is enabled to produce nonpersistent messages every sixty seconds. The messages are allowed to remain in their respective destinations for 5 minutes before being automatically deleted. To persist metrics messages, to change the interval at which they are produced, or to change their time-to-live interval, the administrator must set the following properties in the `config.properties` file: `imq.metrics.topic.persist` , `imq.metrics.topic.interval`, and `imq.metrics.topic.timetolive` .

In addition, the administrator might want to set access controls on the metrics destinations. This restricts access to sensitive metrics data and helps limit the impact of metrics subscriptions on overall performance. For more information about administrative tasks in enabling message-based monitoring and access control, see "Using the Message-Based Monitoring API" in *Open Message Queue Administration Guide*.

Implementation Summary

The following task list summarizes the steps required to implement message based monitoring:

To Implement Message-Based Monitoring

1. The developer designs and writes a client that subscribes to one or more metrics destinations.
2. The administrator sets those metrics-related broker properties whose default values are not satisfactory.
3. *(Optional)* The administrator sets entries in the `access.control.properties` file to restrict access to metrics information.
4. The developer or the administrator starts the metrics monitoring client.

   When consumers subscribe to a metrics topic, the topic's physical destination is automatically created. After the metrics topic has been created, the broker's metrics message producer begins to send metrics messages to the appropriate destination.

Creating a Metrics-Monitoring Client

You create a metrics monitoring client in the same way that you would write any JMS client, except that the client must subscribe to one or more special metrics message topic and must be ready to receive and process messages of a specific type and format.

No hierarchical naming scheme is implied in the metrics-message names. You can't use a wildcard character (`*`) to identify multiple destination names.

A client that monitors broker metrics must perform the following basic tasks:

To Monitor Broker Metrics

1. Create a `TopicConnectionFactory` object.
2. Create a `TopicConnection` to the Message Queue service.
3. Create a `TopicSession`.
4. Create a metrics `Topic` destination object.
5. Create a `TopicSubscriber`.
6. Register as an asynchronous listener to the topic, or invoke the synchronous `receive()` method to wait for incoming metrics messages.
7. Process metrics messages that are received.

   In general, you would use JNDI lookups of administered objects to make your client code provider-independent. However, the metrics-message production is specific to Message Queue, there is no compelling reason to use JNDI lookups. You can simply instantiate these administered objects directly in your client code. This is especially true for a metrics destination for which an administrator would not normally create an administered object.

   Notice that the code examples in this chapter instantiate all the relevant administered objects directly.

   You can use the following code to extract the type (`String`) or timestamp (`long`) properties in the message header from the message:

```
MapMessage mapMsg;
/*
* mapMsg is the metrics message received
*/
String type = mapMsg.getStringProperty("type");
long timestamp = mapMsg.getLongProperty("timestamp");
```

You use the appropriate get method in the class `javax.jms.MapMessage` to extract the name-value pairs. The get method you use depends on the value type. Three examples follow:

```
long value1 = mapMsg.getLong("numMsgsIn");
long value2 = mapMsg.getLong("numMsgsOut");
int value3 = mapMsg.getInt("diskUtilizationRatio");
```

Format of Metrics Messages

In order to consume and process a metrics messages, you must know its type and format. This section describes the general format of metrics messages and provides detailed information on the format of each type of metrics message.

Metrics messages are of type `MapMessage`. (A type of message whose body contains a set of name-value pairs. The order of entries is not defined.)

- The message header has properties that are useful to applications. The `type` property identifies the type of metric message (and therefore its contents). It is useful if the same subscriber processes more than one type of metrics message for example, messages from the topics `mq.metrics.broker` and `mq.metrics.jvm`. The `timestamp` property indicates when the metric sample was taken and is useful for calculating rates or drawing graphs. The `brokerHost`, `brokerPort`, and `brokerAddress` properties identify the broker that sent the metric message and are useful when a single application needs to process metric messages from different brokers.
- The body of the message contains name-value pairs, and the data values depend on the type of metrics message. The following subsections describe the format of each metrics message type.

Note that the names of name-value pairs (used in code to extract data) are case-sensitive and must be coded exactly as shown. For example, `NumMsgsOut` is incorrect; `numMsgsOut` is correct.

Broker Metrics

The messages you receive when you subscribe to the topic `mq.metrics.broker` have the type property set to `mq.metrics.broker` in the message header and have the data listed in Table 5–2 in the message body.

Table 5–2 Data in the Body of a Broker Metrics Message

Metric Name	Value Type	Description
`numConnections`	long	Current number of connections to the broker
`numMsgsIn`	long	Number of JMS messages that have flowed into the broker since it was last started
`numMsgsOut`	long	Number of JMS messages that have flowed out of the broker since it was last started

Table 5–2 (Cont.) Data in the Body of a Broker Metrics Message

Metric Name	Value Type	Description
`numMsgs`	long	Current number of JMS messages stored in broker memory and persistent store
`msgBytesIn`	long	Number of JMS message bytes that have flowed into the broker since it was last started
`msgBytesOut`	long	Number of JMS message bytes that have flowed out of the broker since it was last started
`totalMsgBytes`	long	Current number of JMS message bytes stored in broker memory and persistent store
`numPktsIn`	long	Number of packets that have flowed into the broker since it was last started; this includes both JMS messages and control messages
`numPktsOut`	long	Number of packets that have flowed out of the broker since it was last started; this includes both JMS messages and control messages
`pktBytesIn`	long	Number of packet bytes that have flowed into the broker since it was last started; this includes both JMS messages and control messages
`pktBytesOut`	long	Number of packet bytes that have flowed out of the broker since it was last started; this includes both JMS messages and control messages
`numDestinations`	long	Current number of destinations in the broker

JVM Metrics

The messages you receive when you subscribe to the topic `mq.metrics.jvm` have the type property set to `mq.metrics.jvm` in the message header and have the data listed in Table 5–3 in the message body.

Table 5–3 Data in the Body of a JVM Metrics Message

Metric Name	Value Type	Description
`freeMemory`	long	Amount of free memory available for use in the JVM heap
`maxMemory`	long	Maximum size to which the JVM heap can grow
`totalMemory`	long	Total memory in the JVM heap

Destination-List Metrics

The messages you receive when you subscribe to a topic named `mq.metrics.destination_list` have the `type` property set to `mq.metrics.destination_list` in the message header.

The message body contains a list of map names. Each destination on the broker is specified by a unique map name (a name-value pair) in the message body. The type of the name-value pair is `hashtable`.

The *name* (in the name-value pair) depends on whether the destination is a queue or a topic, and is constructed as follows:

- `mq.metrics.destination.queue.`*monitored_destination_name*
- `mq.metrics.destination.topic.`*monitored_destination_name*

The *value* (in the name-value pair) is an object of type `java.util.Hashtable`. This hashtable contains the key-value pairs described in Table 5–4.

Table 5–4 Value of a Name-Value Pair

Key (String)	Value type	Value or Description
`name`	String	Destination name
`type`	String	Destination type (`queue` or `topic`)
`isTemporary`	Boolean	Is destination temporary?

Notice that the destination name and type could be extracted directly from the metrics topic destination name, but the hashtable includes it for your convenience.

By enumerating through the map names and extracting the hashtable described in Table 5–4, you can form a complete list of destination names and some of their characteristics.

The destination list does not include the following kinds of destinations:

- Destinations that are used by Message Queue administration tools
- Destinations that the Message Queue broker creates for internal use

Destination Metrics

The messages you receive when you subscribe to the topic `mq.metrics.destination.queue.`*monitored_destination_name* have the type property `mq.metrics.destination.queue.`*monitored_destination_name* set in the message header. The messages you receive when you subscribe to the topic `mq.metrics.destination.topic.`*monitored_destination_name* have the type property `mq.metrics.destination.topic.` *monitored_destination_name* set in the message header. Either of these messages has the data listed in Table 5–5 in the message body.

Table 5–5 Data in the Body of a Destination Metrics Message

Metric Name	Value Type	Description
`numActiveConsumers`	long	Current number of active consumers
`avgNumActiveConsumers`	long	Average number of active consumers since the broker was last started
`peakNumActiveConsumers`	long	Peak number of active consumers since the broker was last started
`numBackupConsumers`	long	Current number of backup consumers (applies only to queues)
`avgNumBackupConsumers`	long	Average number of backup consumers since the broker was last started (applies only to queues)
`peakNumBackupConsumers`	long	Peak number of backup consumers since the broker was last started (applies only to queues)
`numMsgsIn`	long	Number of JMS messages that have flowed into this destination since the broker was last started

Table 5–5 (Cont.) Data in the Body of a Destination Metrics Message

Metric Name	Value Type	Description
`numMsgsOut`	long	Number of JMS messages that have flowed out of this destination since the broker was last started
`numMsgs`	long	Number of JMS messages currently stored in destination memory and persistent store
`avgNumMsgs`	long	Average number of JMS messages stored in destination memory and persistent store since the broker was last started
`peakNumMsgs`	long	Peak number of JMS messages stored in destination memory and persistent store since the broker was last started
`msgBytesIn`	long	Number of JMS message bytes that have flowed into this destination since the broker was last started
`msgBytesOut`	long	Number of JMS message bytes that have flowed out of this destination since the broker was last started
`totalMsgBytes`	long	Current number of JMS message bytes stored in destination memory and persistent store
`avgTotalMsgBytes`	long	Average number of JMS message bytes stored in destination memory and persistent store since the broker was last started
`peakTotalMsgBytes`	long	Peak number of JMS message bytes stored in destination memory and persistent store since the broker was last started
`peakMsgBytes`	long	Peak number of JMS message bytes in a single message since the broker was last started
`diskReserved`	long	Disk space (in bytes) used by all message records (active and free) in the destination file-based store
`diskUsed`	long	Disk space (in bytes) used by active message records in destination file-based store
`diskUtilizationRatio`	int	Quotient of used disk space over reserved disk space. The higher the ratio, the more the disk space is being used to hold active messages

Metrics Monitoring Client Code Examples

Several complete monitoring example applications (including source code and full documentation) are provided when you install Message Queue. You'll find the examples in your IMQ home directory under `/demo/monitoring`. Before you can run these clients, you must set up your environment (for example, the `CLASSPATH` environment variable). For details, see Setting Up Your Environment.

Next are brief descriptions of three examples—Broker Metrics, Destination List Metrics, and Destination Metrics—with annotated code examples from each.

These examples use the utility classes `MetricsPrinter` and `MultiColumnPrinter` to print formatted and aligned columns of text output. However, rather than explaining how those utility classes are used, the following code examples focus on how to subscribe to the metrics topic and how to extract information from the metrics messages received.

Notice that in the source files, the code for subscribing to metrics topics and processing messages is actually spread across various methods. However, for the sake of clarity, the examples are shown here as though they were contiguous blocks of code.

A Broker Metrics Example

The source file for this code example is `BrokerMetrics.java`. This metrics monitoring client subscribes to the topic `mq.metrics.broker` and prints broker-related metrics to the standard output.

Example 5–1 shows how to subscribe to `mq.metrics.broker`.

Example 5–1 Example of Subscribing to a Broker Metrics Topic

```
com.sun.messaging.TopicConnectionFactory metricConnectionFactory;
    TopicConnection             metricConnection;
    TopicSession                metricSession;
    TopicSubscriber             metricSubscriber;
    Topic                       metricTopic;

    metricConnectionFactory = new com.sun.messaging.TopicConnectionFactory();

    metricConnection = metricConnectionFactory.createTopicConnection();
    metricConnection.start();

    metricSession = metricConnection.createTopicSession(false,
                      Session.AUTO_ACKNOWLEDGE);

    metricTopic = metricSession.createTopic("mq.metrics.broker");

    metricSubscriber = metricSession.createSubscriber(metricTopic);
    metricSubscriber.setMessageListener(this);
```

The incoming message is processed in the `onMessage()` and `doTotals()` methods, as shown in Example 5–2.

Example 5–2 Example of Processing a Broker Metrics Message

```
public void onMessage(Message m)  {
    try  {
            MapMessage mapMsg = (MapMessage)m;
            String type = mapMsg.getStringProperty("type");

            if (type.equals("mq.metrics.broker"))  {
                if (showTotals)  {
                        doTotals(mapMsg);
            ...
            }
}

private void doTotals(MapMessage mapMsg)  {
    try  {
            String oneRow[] = new String[ 8 ];
            int i = 0;

            /*
            * Extract broker metrics
            */
            oneRow[i++] = Long.toString(mapMsg.getLong("numMsgsIn"));
```

```
                oneRow[i++] = Long.toString(mapMsg.getLong("numMsgsOut"));
                oneRow[i++] = Long.toString(mapMsg.getLong("msgBytesIn"));
                oneRow[i++] = Long.toString(mapMsg.getLong("msgBytesOut"));
                oneRow[i++] = Long.toString(mapMsg.getLong("numPktsIn"));
                oneRow[i++] = Long.toString(mapMsg.getLong("numPktsOut"));
                oneRow[i++] = Long.toString(mapMsg.getLong("pktBytesIn"));
                oneRow[i++] = Long.toString(mapMsg.getLong("pktBytesOut"));
                ...
        } catch (Exception e)  {
                System.err.println("onMessage: Exception caught: " + e);
        }
}
```

Notice how the metrics type is extracted, using the `getStringProperty()` method, and is checked. If you use the `onMessage()` method to process metrics messages of different types, you can use the `type` property to distinguish between different incoming metrics messages.

Also notice how various pieces of information on the broker are extracted, using the `getLong()` method of `mapMsg`.

Run this example monitoring client with the following command:

```
java BrokerMetrics
```

The output looks like the following:

```
----------------------------------------------------------------
Msgs            Msg Bytes         Pkts                  Pkt     Bytes
In      Out     In        Out     In        Out         In        Out
--------------------------------------------------------------------
0       0        0        0       6         5           888       802
0       1        0        633     7         8           1004      1669
```

A Destination List Metrics Example

The source file for this code example is `DestListMetrics.java`. This client application monitors the list of destinations on a broker by subscribing to the topic `mq.metrics.destination_list`. The messages that arrive contain information describing the destinations that currently exist on the broker, such as destination name, destination type, and whether the destination is temporary.

Example 5–3 shows how to subscribe to `mq.metrics.destination_list`.

Example 5–3 Example of Subscribing to the Destination List Metrics Topic

```
com.sun.messaging.TopicConnectionFactory metricConnectionFactory;
TopicConnection             metricConnection;
TopicSession                metricSession;
TopicSubscriber             metricSubscriber;
Topic                       metricTopic;
String                      metricTopicName = null;

metricConnectionFactory = new com.sun.messaging.TopicConnectionFactory();
metricConnection = metricConnectionFactory.createTopicConnection();
metricConnection.start();

metricSession = metricConnection.createTopicSession(false,
                    Session.AUTO_ACKNOWLEDGE);
```

```
metricTopicName = "mq.metrics.destination_list";
metricTopic = metricSession.createTopic(metricTopicName);

metricSubscriber = metricSession.createSubscriber(metricTopic);
metricSubscriber.setMessageListener(this);
```

The incoming message is processed in the `onMessage()` method, as shown in Example 5–4:

Example 5–4 Example of Processing a Destination List Metrics Message

```
public void onMessage(Message m)  {
    try{
         MapMessage mapMsg = (MapMessage)m;
         String type = mapMsg.getStringProperty("type");

         if (type.equals(metricTopicName))  {
             String oneRow[] = new String[ 3 ];

             /*
             * Extract metrics
             */
             for (Enumeration e = mapMsg.getMapNames();
                  e.hasMoreElements();) {

                  String metricDestName = (String)e.nextElement();
                  Hashtable destValues =
                                (Hashtable)mapMsg.getObject(metricDestName);
                  int i = 0;

                  oneRow[i++] = (destValues.get("name")).toString();
                  oneRow[i++] = (destValues.get("type")).toString();
                  oneRow[i++] = (destValues.get("isTemporary")).toString();

                  mp.add(oneRow);
             }

             mp.print();
             System.out.println("");

             mp.clear();
         } else  {
                System.err.println("Msg received:
                        not destination list metric type");
            }
    } catch (Exception e)  {
            System.err.println("onMessage: Exception caught: " + e);
    }
}
```

Notice how the metrics type is extracted and checked, and how the list of destinations is extracted. By iterating through the map names in `mapMsg` and extracting the corresponding value (a hashtable), you can construct a list of all the destinations and their related information.

As discussed in Format of Metrics Messages, these map names are metrics topic names having one of two forms:

`mq.metrics.destination.queue.`*`monitored_destination_name`* mq.metrics.destination.topic.*monitored_destination_name*

(The map names can also be used to monitor a destination, but that is not done in this particular example.)

Notice that from each extracted hashtable, the information on each destination is extracted using the keys `name`, `type`, and `isTemporary`. The extraction code from the previous code example is reiterated here for your convenience.

Example 5–5   Example of Extracting Destination Information From a Hash Table

```
  String metricDestName = (String)e.nextElement();
        Hashtable destValues = (Hashtable)mapMsg.getObject(metricDestName);
        int i = 0;

        oneRow[i++] = (destValues.get("name")).toString();
        oneRow[i++] = (destValues.get("type")).toString();
        oneRow[i++] = (destValues.get("isTemporary")).toString();
```

Run this example monitoring client with the following command:

```
java DestListMetrics
```

The output looks like the following:

```
---------------------------------------------------
Destination Name       Type          IsTemporary
---------------------------------------------------
SimpleQueue            queue          false
fooQueue               queue          false
topic1                 topic          false
```

A Destination Metrics Example

The source file for this code example is `DestMetrics.java`. This client application monitors a specific destination on a broker. It accepts the destination type and name as parameters, and it constructs a metrics topic name of the form `mq.metrics.destination.queue.`*monitored_destination_name* or `mq.metrics.destination.topic.`*monitored_destination_name* .

Example 5–6 shows how to subscribe to the metrics topic for monitoring a specified destination.

Example 5–6   Example of Subscribing to a Destination Metrics Topic

```
com.sun.messaging.TopicConnectionFactory metricConnectionFactory;
TopicConnection             metricConnection;
TopicSession                metricSession;
TopicSubscriber             metricSubscriber;
Topic                       metricTopic;
String                      metricTopicName = null;
String                      destName = null,
                            destType = null;

for (int i = 0; i < args.length; ++i)  {
    ...
    } else if (args[i].equals("-n"))  {
            destName = args[i+1];
    } else if (args[i].equals("-t"))  {
            destType = args[i+1];
    }
}

metricConnectionFactory = new com.sun.messaging.TopicConnectionFactory();

metricConnection = metricConnectionFactory.createTopicConnection();
metricConnection.start();

metricSession = metricConnection.createTopicSession(false,
                   Session.AUTO_ACKNOWLEDGE);

if (destType.equals("q"))  {
    metricTopicName = "mq.metrics.destination.queue." + destName;
} else  {
    metricTopicName = "mq.metrics.destination.topic." + destName;
}

metricTopic = metricSession.createTopic(metricTopicName);

metricSubscriber = metricSession.createSubscriber(metricTopic);
metricSubscriber.setMessageListener(this);
```

The incoming message is processed in the `onMessage()` method, as shown in Example 5–7:

Example 5–7 Example of Processing a Destination Metrics Message

```
public void onMessage(Message m)  {
   try {
        MapMessage mapMsg = (MapMessage)m;
        String type = mapMsg.getStringProperty("type");

        if (type.equals(metricTopicName))  {
            String oneRow[] = new String[ 11 ];
            int i = 0;

            /*
            * Extract destination metrics
            */
            oneRow[i++] = Long.toString(mapMsg.getLong("numMsgsIn"));
            oneRow[i++] = Long.toString(mapMsg.getLong("numMsgsOut"));
            oneRow[i++] = Long.toString(mapMsg.getLong("msgBytesIn"));
            oneRow[i++] = Long.toString(mapMsg.getLong("msgBytesOut"));

            oneRow[i++] = Long.toString(mapMsg.getLong("numMsgs"));
            oneRow[i++] = Long.toString(mapMsg.getLong("peakNumMsgs"));
            oneRow[i++] = Long.toString(mapMsg.getLong("avgNumMsgs"));

            oneRow[i++] = Long.toString(mapMsg.getLong("totalMsgBytes")/1024);
            oneRow[i++] = Long.toString
                           (mapMsg.getLong("peakTotalMsgBytes")/1024);
            oneRow[i++] = Long.toString
                           (mapMsg.getLong("avgTotalMsgBytes")/1024);

            oneRow[i++] = Long.toString(mapMsg.getLong("peakMsgBytes")/1024);

            mp.add(oneRow);
            ...
            }
    } catch (Exception e)  {
            System.err.println("onMessage: Exception caught: " + e);
    }
}
```

Notice how the metrics type is extracted, using the `getStringProperty()` method as in the previous examples, and is checked. Also notice how various destination data are extracted, using the `getLong()` method of `mapMsg`.

You can run this example monitoring client with one of the following commands:

```
java DestMetrics -t t -n topic_name
java DestMetrics -t q -n queue_name
```

Using a queue named `SimpleQueue` as an example, the command would be:

```
java DestMetrics -t q -n SimpleQueue
```

The output looks like the following:

```
-----------------------------------------------------------------------------
Msgs        Msg   Bytes  Msg Count        Tot Msg Bytes(k)    Largest Msg
In   Out    In    Out    Curr  Peak  Avg  Curr  Peak  Avg     (k)
-----------------------------------------------------------------------------
500   0   318000  0      500   500   250  310   310   155      0
```

6 Working with SOAP Messages

SOAP is a protocol that allows for the exchange of data whose structure is defined by an XML scheme. Using Message Queue, you can send JMS messages that contain a SOAP payload. This allows you to transport SOAP messages reliably and to publish SOAP messages to JMS subscribers. This chapter covers the following topics:

- What is SOAP?
- SOAP Messaging in JAVA
- SOAP Messaging Models and Examples
- Integrating SOAP and Message Queue

If you are familiar with the SOAP specification, you can skip the introductory section and start by reading SOAP Messaging in JAVA.

What is SOAP?

SOAP, the Simple Object Access Protocol, is a protocol that allows the exchange of structured data between peers in a decentralized, distributed environment. The structure of the data being exchanged is specified by an XML scheme.

The fact that SOAP messages are encoded in XML makes SOAP messages portable, because XML is a portable, system-independent way of representing data. By representing data using XML, you can access data from legacy systems as well as share your data with other enterprises. The data integration offered by XML also makes this technology a natural for Web-based computing such as Web services. Firewalls can recognize SOAP packets based on their content type (`text/xml-SOAP`) and can filter messages based on information exposed in the SOAP message header.

The SOAP specification describes a set of conventions for exchanging XML messages. As such, it forms a natural foundation for Web services that also need to exchange information encoded in XML. Although any two partners could define their own protocol for carrying on this exchange, having a standard such as SOAP allows developers to build the generic pieces that support this exchange. These pieces might be software that adds functionality to the basic SOAP exchange, or might be tools that administer SOAP messaging, or might even comprise parts of an operating system that supports SOAP processing. Once this support is put in place, other developers can focus on creating the Web services themselves.

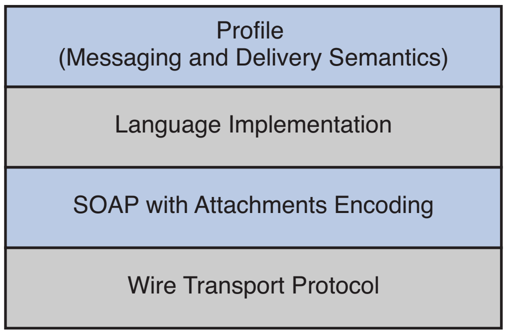
The SOAP protocol is fully described at http://www.w3.org/TR/SOAP. This section restricts itself to discussing the reasons why you would use SOAP and to describing basic concepts that will make it easier to work with SOAP messages.

SOAP with Attachments API for Java

The Soap with Attachments API for Java (SAAJ) is a JAVA-based API that enforces compliance to the SOAP standard. When you use this API to assemble and disassemble SOAP messages, it ensures the construction of syntactically correct SOAP messages. SAAJ also makes it possible to automate message processing when several applications need to handle different parts of a message before forwarding it to the next recipient.

Figure 6–1 shows the layers that can come into play in the implementation of SOAP messaging. This chapter focuses on the SOAP and language implementation layers.

Figure 6–1 SOAP Messaging Layers


Profile
(Messaging and Delivery Semantics)
Language Implementation
SOAP with Attachments Encoding
Wire Transport Protocol

The sections that follow describe each layer shown in the preceding figure in greater detail. The rest of this chapter focuses on the SOAP and language implementation layers.

The Transport Layer

Underlying any messaging system is the transport or wire protocol that governs the serialization of the message as it is sent across a wire and the interpretation of the message bits when it gets to the other side. Although SOAP messages can be sent using any number of protocols, the SOAP specification defines only the binding with HTTP. SOAP uses the HTTP request/response message model. It provides SOAP request parameters in an HTTP request and SOAP response parameters in an HTTP response. The HTTP binding has the advantage of allowing SOAP messages to go through firewalls.

The SOAP Layer

Above the transport layer is the SOAP layer. This layer, which is defined in the SOAP Specification, specifies the XML scheme used to identify the message parts: envelope, header, body, and attachments. All SOAP message parts and contents, except for the attachments, are written in XML. The following sample SOAP message shows how XML tags are used to define a SOAP message:

```
<SOAP-ENV:Envelope
   xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
   SOAP-ENV:encodingStyle=
           "http://schemas.xmlsoap.org/soap/encoding/">
      <SOAP-ENV:Body>
          <m:GetLastTradePrice xmlns:m="Some-URI">
              <symbol>DIS</symbol>
          </m:GetLastTradePrice>
      </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

The wire transport and SOAP layers are actually sufficient to do SOAP messaging. You could create an XML document that defines the message you want to send, and you could write HTTP commands to send the message from one side and to receive it on the other. In this case, the client is limited to sending synchronous messages to a specified URL. Unfortunately, the scope and reliability of this kind of messaging is severely restricted. To overcome these limitations, the *provider* and *profile* layers are added to SOAP messaging.

The Language Implementation Layer

A language implementation allows you to create XML messages that conform to SOAP, using API calls. For example, the SAAJ implementation of SOAP, allows a Java client to construct a SOAP message and all its parts as Java objects. The client would also use SAAJ to create a connection and use it to send the message. Likewise, a Web service written in Java could use the same implementation (SAAJ), or any other language implementation, to receive the message, to disassemble it, and to acknowledge its receipt.

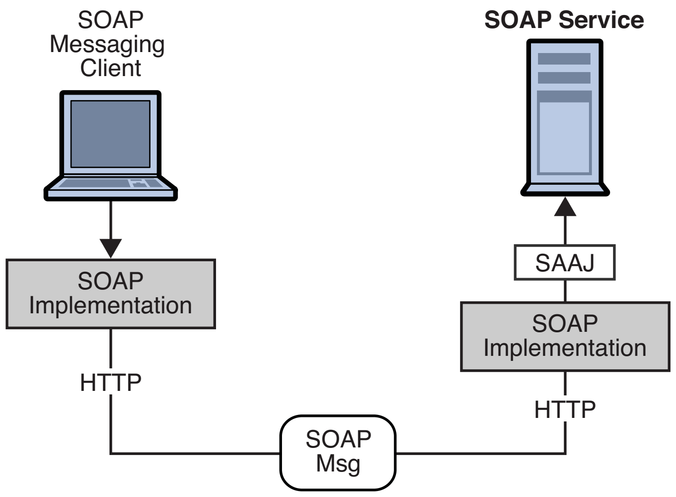
The Profiles Layer

In addition to a language implementation, a SOAP implementation can offer services that relate to message delivery. These could include reliability, persistence, security, and administrative control, and are typically delivered by a SOAP messaging provider. These services will be provided for SOAP messaging by Message Queue in future releases.

Interoperability

Because SOAP providers must all construct and deconstruct messages as defined by the SOAP specification, clients and services using SOAP are interoperable. That is, as shown in Figure 6–2, the client and the service doing SOAP messaging do not need to be written in the same language nor do they need to use the same SOAP provider. It is only the packaging of the message that must be standard.

Figure 6–2 SOAP Interoperability



In order for a SAAJ client or service to interoperate with a service or client using a different implementation, the parties must agree on two things:

- They must use the same transport bindings--that is, the same wire protocol.
- They must use the same profile in constructing the SOAP message being sent.

The SOAP Message

Having surveyed the SOAP messaging layers, let's examine the SOAP message itself. Although the work of rendering a SOAP message in XML is taken care of by the SAAJ implementation, you must still understand its structure in order to make the SAAJ calls in the right order.

A *SOAP message* is an XML document that consists of a SOAP envelope, an optional SOAP header, and a SOAP body. The SOAP message header contains information that allows the message to be routed through one or more intermediate nodes before it reaches its final destination.

- The *envelope* is the root element of the XML document representing the message. It defines the framework for how the message should be handled and by whom. Once it encounters the Envelope element, the SOAP processor knows that the XML is a SOAP message and can then look for the individual parts of the message.
- The *header* is a generic mechanism for adding features to a SOAP message. It can contain any number of child elements that define extensions to the base protocol. For example, header child elements might define authentication information, transaction information, locale information, and so on. The *actors*, the software that handle the message may, without prior agreement, use this mechanism to define who should deal with a feature and whether the feature is mandatory or optional.
- The *body* is a container for mandatory information intended for the ultimate recipient of the message.

A SOAP message may also contain an attachment, which does not have to be in XML. For more information, see SOAP Packaging Models next.

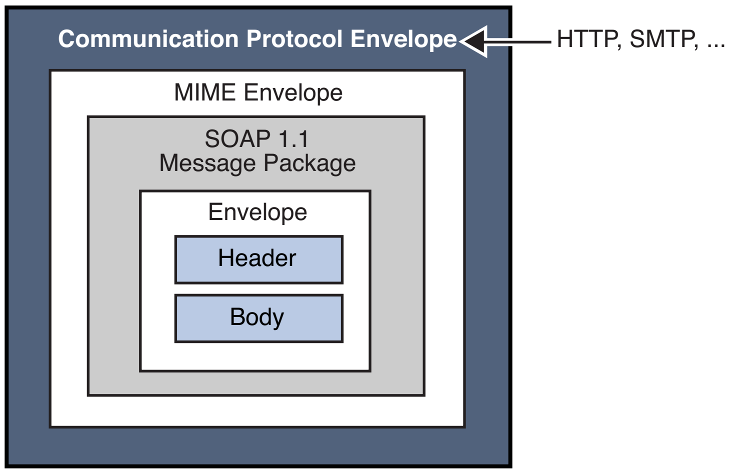
A SOAP message is constructed like a nested matrioshka doll. When you use SAAJ to assemble or disassemble a message, you need to make the API calls in the appropriate order to get to the message part that interests you. For example, in order to add content to the message, you need to get to the body part of the message. To do this you need to work through the nested layers: SOAP part, SOAP envelope, SOAP body, until you get to the SOAP body element that you will use to specify your data. For more information, see The SOAP Message Object.

SOAP Packaging Models

The SOAP specification describes two models of SOAP messages: one that is encoded entirely in XML and one that allows the sender to add an attachment containing non-XML data. You should look over the following two figures and note the parts of the SOAP message for each model. When you use SAAJ to define SOAP messages and their parts, it will be helpful for you to be familiar with this information.

Figure 6–3 shows the SOAP model without attachments. This package includes a SOAP envelope, a header, and a body. The header is optional.

Figure 6–3 SOAP Message Without Attachments

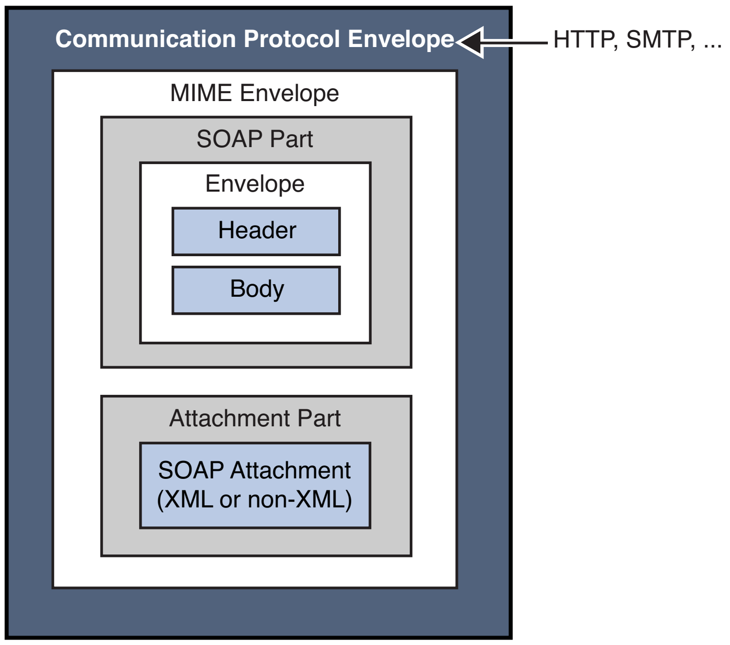


When you construct a SOAP message using SAAJ, you do not have to specify which model you're following. If you add an attachment, a message like that shown in Figure 6–4 is constructed; if you don't, a message like that shown in Figure 6–3 is constructed.

Figure 6–3 shows a SOAP Message with attachments. The attachment part can contain any kind of content: image files, plain text, and so on. The sender of a message can choose whether to create a SOAP message with attachments. The message receiver can also choose whether to consume an attachment.

A message that contains one or more attachments is enclosed in a MIME envelope that contains all the parts of the message. In SAAJ, the MIME envelope is automatically produced whenever the client creates an attachment part. If you add an attachment to a message, you are responsible for specifying (in the MIME header) the type of data in the attachment.

Figure 6–4 SOAP Message with Attachments



SOAP Messaging in JAVA

The SOAP specification does not provide a programming model or even an API for the construction of SOAP messages; it simply defines the XML schema to be used in packaging a SOAP message.

SAAJ is an application programming interface that can be implemented to support a programming model for SOAP messaging and to furnish Java objects that application or tool writers can use to construct, send, receive, and examine SOAP messages. SAAJ defines two packages:

- `javax.xml.soap`: you use the objects in this package to define the parts of a SOAP message and to assemble and disassemble SOAP messages. You can also use this package to send a SOAP message without the support of a provider.
- `javax.xml.messaging`: you use the objects in this package to send a SOAP message using a provider and to receive SOAP messages.

> **Note:** Beginning with SAAJ 1.3, you must put the file `mail.jar` explicitly in `CLASSPATH`.

This chapter focuses on the `javax.xml.soap` package and how you use the objects and methods it defines

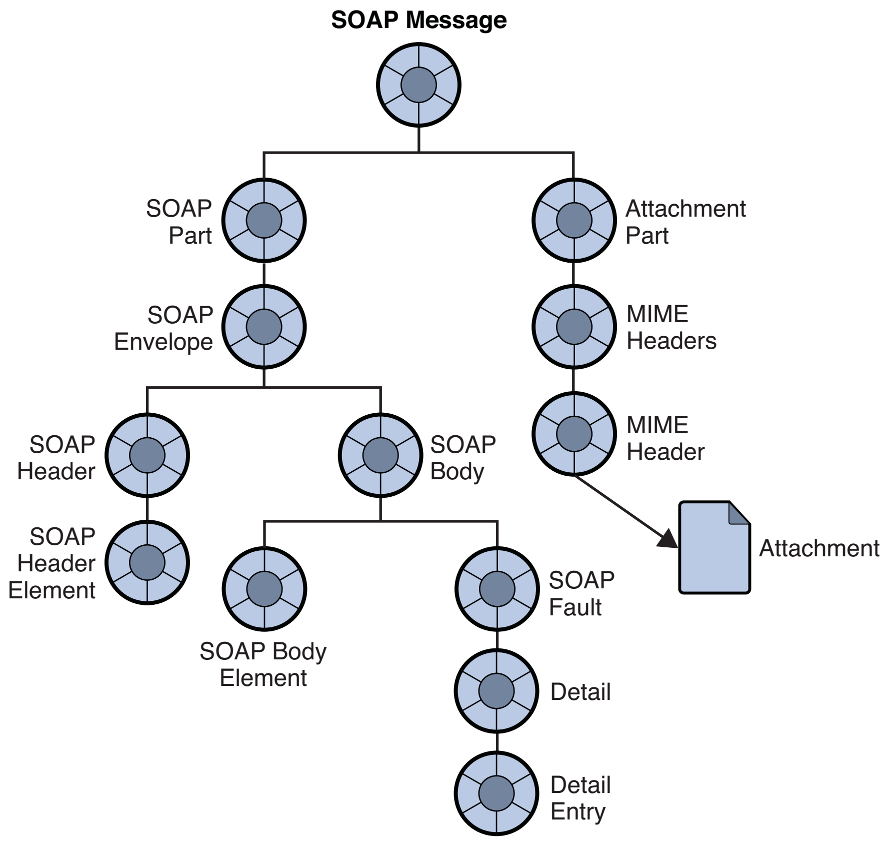
- to assemble and disassemble SOAP messages
- to send and receive these messages

It also explains how you can use the JMS API and Message Queue to send and receive JMS messages that carry SOAP message payloads.

The SOAP Message Object

A SOAP Message Object is a tree of objects as shown in Figure 6–5. The classes or interfaces from which these objects are derived are all defined in the `javax.xml.soap` package.

Figure 6–5 SOAP Message Object



As shown in the figure, the `SOAPMessage` object is a collection of objects divided in two parts: a SOAP part and an attachment part. The main thing to remember is that the attachment part can contain non-xml data.

The SOAP part of the message contains an envelope that contains a body (which can contain data or fault information) and an optional header. When you use SAAJ to create a SOAP message, the SOAP part, envelope, and body are created for you: you need only create the body elements. To do that you need to get to the parent of the body element, the SOAP body.

In order to reach any object in the SOAPMessage tree, you must traverse the tree starting from the root, as shown in the following lines of code. For example, assuming the SOAPMessage is `MyMsg`, here are the calls you would have to make in order to get the SOAP body:

```
SOAPPart MyPart = MyMsg.getSOAPPart();
SOAPEnvelope MyEnv = MyPart.getEnvelope();
SOAPBody MyBody = envelope.getBody();
```

At this point, you can create a name for a body element (as described in Namespaces) and add the body element to the SOAPMessage.

For example, the following code line creates a name (a representation of an XML tag) for a body element:

```
Name bodyName = envelope.createName("Temperature");
```

The next code line adds the body element to the body:

```
SOAPBodyElement myTemp = MyBody.addBodyElement(bodyName);
```

Finally, this code line defines some data for the body element `bodyName` :

```
myTemp.addTextNode("98.6");
```

Inherited Methods

The elements of a SOAP message form a tree. Each node in that tree implements the `Node` interface and, starting at the envelope level, each node implements the `SOAPElement` interface as well. The resulting shared methods are described in Table 6–1.

Table 6–1 Inherited Methods

Inherited From	Method Name	Purpose
`SOAPElement`	`addAttribute(Name, String)`	Add an attribute with the specified `Name` object and string value

	`addChildElement(Name)`
	`addChildElement(String, String)`
	`addChildElement (String, String, String)`
		Create a new `SOAPElement` object, initialized with the given `Name` object, and add the new element
		(Use the `Envelope.createName` method to create a `Name` object)

	`addNameSpaceDeclaration (String, String)`	Add a namespace declaration with the specified prefix and URI
	`addTextnode(String)`	Create a new `Text` object initialized with the given `String` and add it to this `SOAPElement` object
	`getAllAttributes()`	Return an iterator over all the attribute names in this object
	`getAttributeValue(Name)`	Return the value of the specified attribute
	`getChildElements()`	Return an iterator over all the immediate content of this element
	`getChildElements(Name)`	Return an iterator over all the child elements with the specified name
	`getElementName()`	Return the name of this object
	`getEncodingStyle()`	Return the encoding style for this object
	`getNameSpacePrefixes()`	Return an iterator of namespace prefixes
	`getNamespaceURI(String)`	Return the URI of the namespace with the given prefix
	`removeAttribute(Name)`	Remove the specified attribute

Table 6–1 (Cont.) Inherited Methods

Inherited From	Method Name	Purpose
	`removeNamespaceDeclaration (String)`	Remove the namespace declaration that corresponds to the specified prefix
	`setEncodingStyle(String)`	Set the encoding style for this object to that specified by `String`
`Node`	`detachNode()`	Remove this `Node` object from the tree
	`getParentElement()`	Return the parent element of this `Node` object
	`getValue`	Return the value of the immediate child of this `Node` object if a child exists and its value is `text`
	`recycleNode()`	Notify the implementation that his `Node` object is no longer being used and is free for reuse
	`setParentElement(SOAPElement)`	Set the parent of this object to that specified by the `SOAPElement` parameter

Namespaces

An *XML namespace* is a means of qualifying element and attribute names to disambiguate them from other names in the same document. This section provides a brief description of XML namespaces and how they are used in SOAP. For complete information, see `http://www.w3.org/TR/REC-xml-names/`

An explicit XML namespace declaration takes the following form:

```
<prefix:myElement
xmlns:prefix ="URI">
```

The declaration defines *prefix* as an alias for the specified URI. In the element `myElement`, you can use *prefix* with any element or attribute to specify that the element or attribute name belongs to the namespace specified by the URI.

The following is an example of a namespace declaration:

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
```

This declaration defines `SOAP_ENV` as an alias for the namespace:

```
http://schemas.xmlsoap.org/soap/envelope/
```

After defining the alias, you can use it as a prefix to any attribute or element in the `Envelope` element. In Example 6–1, the elements `<Envelope>` and `<Body>` and the attribute `encodingStyle` all belong to the SOAP namespace specified by the `http://schemas.sxmlsoap.org/soap/envelope/`URI .

Example 6–1 Explicit Namespace Declarations

```
<SOAP-ENV:Envelope
   xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
   SOAP-ENV:encodingStyle=
                    "http://schemas.xmlsoap.org/soap/encoding/">
```

```
  <SOAP-ENV:Header>
       <HeaderA
xmlns="HeaderURI"
SOAP-ENV:mustUnderstand="0">

     The text of the header
    </HeaderA>
</SOAP-ENV:Header>
  <SOAP-ENV:Body>
.
.
.
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Note that the URI that defines the namespace does not have to point to an actual location; its purpose is to disambiguate attribute and element names.

Pre-defined SOAP Namespaces SOAP defines two namespaces:

- The SOAP envelope, the root element of a SOAP message, has the following namespace identifier:

  `"http://schemas.xmlsoap.org/soap/envelope"`

- The SOAP serialization, the URI defining SOAP's serialization rules, has the following namespace identifier:

  `"http://schemas.xmlsoap.org/soap/encoding"`

When you use SAAJ to construct or consume messages, you are responsible for setting or processing namespaces correctly and for discarding messages that have incorrect namespaces.

Using Namespaces when Creating a SOAP Name When you create the body elements or header elements of a SOAP message, you must use the `Name` object to specify a well-formed name for the element. You obtain a `Name` object by calling the method `SOAPEnvelope.createName`.

When you call this method, you can pass a local name as a parameter or you can specify a local name, prefix, and URI. For example, the following line of code defines a name object `bodyName`.

```
Name bodyName = MyEnvelope.createName("TradePrice",
                                 "GetLTP","http://foo.eztrade.com");
```

This would be equivalent to the namespace declaration:

```
<GetLTP:TradePrice xmlns:GetLTP= "http://foo.eztrade.com">
```

The following code shows how you create a name and associate it with a `SOAPBody` element. Note the use and placement of the `createName` method.

```
SoapBody body = envelope.getBody();//get body from envelope
Name bodyName = envelope.createName("TradePrice", "GetLTP",
                                        "http://foo.eztrade.com");
SOAPBodyElement gltp = body.addBodyElement(bodyName);
```

Parsing Name Objects For any given `Name` object, you can use the following `Name` methods to parse the name:

- `getQualifiedName` returns "*prefix:LocalName* ", for the given name, this would be `GetLTP:TradePrice`.
- `getURI` would return `"http://foo.eztrade.com"` .
- `getLocalName` would return "`TradePrice` ".
- `getPrefix` would return "`GetLTP`".

Destination, Message Factory, and Connection Objects

SOAP messaging occurs when a SOAP message, produced by a *message factory* , is sent to an *endpoint* by way of a *connection* .

If you are working without a provider, you must do the following:

- Create a `SOAPConnectionFactory` object.
- Create a `SOAPConnection object`.
- Create an `Endpoint` object that represents the message's destination.
- Create a `MessageFactory` object and use it to create a message.
- Populate the message.
- Send the message.

If you are working with a provider, you must do the following:

- Create a `ProviderConnectionFactory` object.
- Get a `ProviderConnection` object from the provider connection factory.
- Get a `MessageFactory` object from the provider connection and use it to create a message.
- Populate the message.
- Send the message.

The following three sections describe endpoint, message factory, and connection objects in greater detail.

Endpoint

An *endpoint* identifies the final destination of a message. An endpoint is defined either by the `Endpoint` class (if you use a provider) or by the `URLEndpoint` class (if you don't use a provider).)

Constructing an Endpoint You can initialize an endpoint by calling its constructor. The following code uses a constructor to create a `URLEndpoint`.

```
myEndpoint = new URLEndpoint("http://somehost/myServlet");
```

Using the Endpoint to Address a Message To address a message to an endpoint, specify the endpoint as a parameter to the `SOAPConnection.call` method, which you use to send a SOAP message.

Message Factory

You use a Message Factory to create a SOAP message.

To instantiate a message factory directly, use a statement like the following:

```
MessageFactory mf = MessageFactory.newInstance();
```

Connection

To send a SOAP message using SAAJ, you must obtain a `SOAPConnection` . You can also transport a SOAP message using Message Queue; for more information, see Integrating SOAP and Message Queue.

SOAP Connection

A `SOAPConnection` allows you to send messages directly to a remote party. You can obtain a `SOAPConnection` object simply by calling the static method `SOAPConnectionFactory.newInstance()`. Neither reliability nor security are guaranteed over this type of connection.

SOAP Messaging Models and Examples

This section explains how you use SAAJ to send and receive a SOAP message. It is also possible to construct a SOAP message using SAAJ and to send it as the payload of a JMS message. For information, see Integrating SOAP and Message Queue.

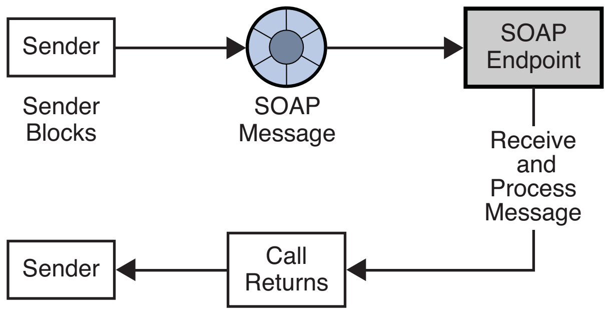
SOAP Messaging Programming Models

This section provides a brief summary of the programming models used in SOAP messaging using SAAJ.

A SOAP message is sent to an endpoint by way of a point-to-point connection (implemented by the `SOAPConnection` class).

You use point-to-point connections to establish a request-reply messaging model. The request-reply model is illustrated in Figure 6–6.

Figure 6–6 Request-Reply Messaging



Using this model, the client does the following:

- Creates an endpoint that specifies the URL that will be passed to the `SOAPConnection.call` method that sends the message.

  See Endpoint for a discussion of the different ways of creating an endpoint.
- Creates a SOAPConnection factory and obtains a SOAP connection.
- Creates a message factory and uses it to create a SOAP message.
- Creates a name for the content of the message and adds the content to the message.
- Uses the `SOAPConnection.call` method to send the message.

It is assumed that the client will ignore the `SOAPMessage` object returned by the call method because the only reason this object is returned is to unblock the client.

The SOAP service listening for a request-reply message uses a `ReqRespListener` object to receive messages.

For a detailed example of a client that does point-to-point messaging, see Writing a SOAP Client.

Working with Attachments

If a message contains any data that is not XML, you must add it to the message as an attachment. A message can have any number of attachment parts. Each attachment part can contain anything from plain text to image files.

To create an attachment, you must create a URL object that specifies the location of the file that you want to attach to the SOAP message. You must also create a data handler that will be used to interpret the data in the attachment. Finally, you need to add the attachment to the SOAP message.

To create and add an attachment part to the message, you need to use the JavaBeans Activation Framework (JAF) API. This API allows you to determine the type of an arbitrary piece of data, encapsulate access to it, discover the operations available on it, and activate a bean that can perform these operations. You must include the `activation.jar` library in your application code in order to work with the JavaBeans Activation Framework.

To Create and Add an Attachment

1. Create a URL object and initialize it to contain the location of the file that you want to attach to the SOAP message.

   ```
   URL url = new URL("http://wombats.com/img.jpg");
   ```

2. Create a data handler and initialize it with a default handler, passing the URL as the location of the data source for the handler.

   ```
   DataHandler dh = new DataHandler(url);
   ```

3. Create an attachment part that is initialized with the data handler containing the URL for the image.

   ```
   AttachmentPart ap1 = message.createAttachmentPart(dh);
   ```

4. Add the attachment part to the SOAP message.

   ```
   myMessage.addAttachmentPart(ap1);
   ```

   After creating the attachment and adding it to the message, you can send the message in the usual way.

   If you are using JMS to send the message, you *can* use the `SOAPMessageIntoJMSMessage` conversion utility to convert a SOAP message that has an attachment into a JMS message that you can send to a JMS queue or topic using Message Queue.

Exception and Fault Handling

A SOAP application can use two error reporting mechanisms: SOAP exceptions and SOAP faults:

- Use a SOAP exception to handle errors that occur on the client side during the generation of the SOAP request or the unmarshalling of the response.
- Use a SOAP fault to handle errors that occur on the server side when unmarshalling the request, processing the message, or marshalling the response. In response to such an error, server-side code should create a SOAP message that contains a fault element, rather than a body element, and then it should send that SOAP message back to the originator of the message. If the message receiver is not the ultimate destination for the message, it should identify itself as the `soapactor` so that the message sender knows where the error occurred. For additional information, see Handling SOAP Faults.

Writing a SOAP Client

The following steps show the calls you have to make to write a SOAP client for point-to-point messaging.

To Write a SOAP Client for Point-to-Point Messaging

1. Get an instance of a `SOAPConnectionFactory`:

   ```
   SOAPConnectionFactory myFct = SOAPConnectionFactory.newInstance();
   ```

2. Get a SOAP connection from the `SOAPConnectionFactory` object:

   ```
   SOAPConnection myCon = myFct.createConnection();
   ```

   The `myCon` object that is returned will be used to send the message.

3. Get a `MessageFactory` object to create a message:

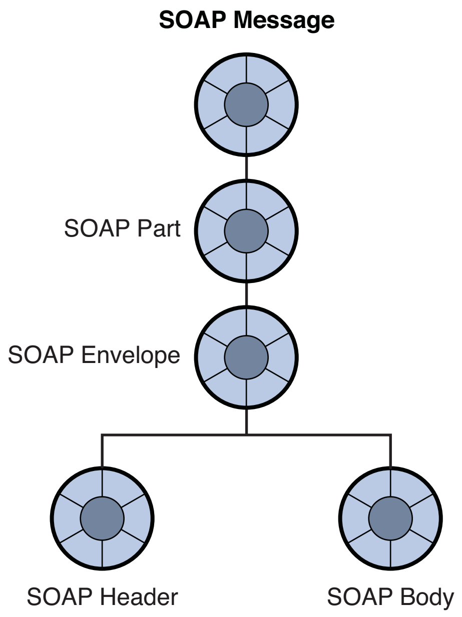
   ```
   MessageFactory myMsgFct = MessageFactory.newInstance();
   ```

4. Use the message factory to create a message:

   ```
   SOAPMessage message = myMsgFct.createMessage();
   ```

   The message that is created has all the parts that are shown in Figure 6–7.

Figure 6–7 SOAP Message Parts



At this point, the message has no content. To add content to the message, you need to create a SOAP body element, define a name and content for it, and then add it to the SOAP body.

Remember that to access any part of the message, you need to traverse the tree, calling a `get` method on the parent element to obtain the child. For example, to reach the SOAP body, you start by getting the SOAP part and SOAP envelope:

```
SOAPPart mySPart = message.getSOAPPart();
SOAPEnvelope myEnvp = mySPart.getEnvelope();
```

5. Now, you can get the body element from the `myEnvp` object:

   ```
   SOAPBody body = myEnvp.getBody();
   ```

   The children that you will add to the body element define the content of the message. (You can add content to the SOAP header in the same way.)

6. When you add an element to a SOAP body (or header), you must first create a name for it by calling the `envelope.createName` method. This method returns a `Name` object, which you must then pass as a parameter to the method that creates the body element (or the header element).

   ```
   Name bodyName = envelope.createName("GetLastTradePrice", "m",
                                          "http://eztrade.com")
   SOAPBodyElement gltp = body.addBodyElement(bodyName);
   ```

7. Now create another body element to add to the `gltp` element:

   ```
   Name myContent = envelope.createName("symbol");
   SOAPElement mySymbol = gltp.addChildElement(myContent);
   ```

8. And now you can define data for the body element `mySymbol`:

   ```
   mySymbol.addTextNode("SUNW");
   ```

   The resulting SOAP message object is equivalent to this XML scheme:

   ```
   <SOAP-ENV: Envelope
   ```

```
    xmlns:SOAPENV="http://schemas.xmlsoap.org/soap/envelope/">
        <SOAP-ENV:Body>
            <m:GetLastTradePrice xmlns:m="http://eztrade.com">
                <symbol>SUNW</symbol>
            </m:GetLastTradePrice>
    </SOAP-ENV:Body>
</SOAP-ENV: Envelope>
```

9. Every time you send a message or write to it, the message is automatically saved. However if you change a message you have received or one that you have already sent, this would be the point when you would need to update the message by saving all your changes. For example:

   ```
   message.saveChanges();
   ```

10. Before you send the message, you must create a `URLEndpoint` object with the URL of the endpoint to which the message is to be sent. (If you use a profile that adds addressing information to the message header, you do not need to do this.)

    ```
    URLEndpoint endPt = new URLEndpoint("http://eztrade.com//quotes");
    ```

11. Now, you can send the message:

    ```
    SOAPMessage reply = myCon.call(message, endPt);
    ```

    The reply message (`reply`) is received on the same connection.

12. Finally, you need to close the `SOAPConnection` object when it is no longer needed:

    ```
    myCon.close();
    ```

Writing a SOAP Service

A SOAP service represents the final recipient of a SOAP message and should currently be implemented as a servlet. You can write your own servlet or you can extend the `JAXMServlet` class, which is furnished in the `soap.messaging` package for your convenience. This section describes the task of writing a SOAP service based on the `JAXMServlet` class.

Your servlet must implement either the `ReqRespListener` or `OneWayListener` interfaces. The difference between these two is that `ReqRespListener` requires that you return a reply.

Using either of these interfaces, you must implement a method called `onMessage(SOAPMsg)`. `JAXMServlet` will call `onMessage` after receiving a message using the `HTTP POST` method, which saves you the work of implementing your own `doPost()` method to convert the incoming message into a SOAP message.

Example 6–2 shows the basic structure of a SOAP service that uses the `JAXMServlet` utility class.

Example 6–2 Skeleton Message Consumer

```
public class MyServlet extends JAXMServlet implements
                                 ReqRespListener
{
    public SOAPMessage onMessage(SOAP Message msg)
    { //Process message here
    }
}
```

Example 6–3 shows a simple ping message service:

Example 6–3 A Simple Ping Message Service

```
public class SOAPEchoServlet extends JAXMServlet
                                         implements ReqRespListener{

    public SOAPMessage onMessage(SOAPMessage mySoapMessage) {
        return mySoapMessage
    }
}
```

Table 6–2 describes the methods that the JAXM servlet uses. If you were to write your own servlet, you would need to provide methods that performed similar work. In extending `JAXMServlet` , you may need to override the `Init` method and the `SetMessageFactory` method; you *must* implement the `onMessage` method.

Table 6–2 `JAXMServlet` Methods

Method	Description
`void init (ServletConfig)`	Passes the `ServletConfig` object to its parent's constructor and creates a default `messageFactory` object. If you want incoming messages to be constructed according to a certain profile, you must call the `SetMessageFactory` method and specify the profile it should use in constructing SOAP messages.
`void doPost (HTTPRequest, HTTPResponse`	Gets the body of the HTTP request and creates a SOAP message according to the default or specified MessageFactory profile. Calls the `onMessage`() method of an appropriate listener, passing the SOAP message as a parameter. It is recommended that you do not override this method.
`void setMessageFactory (MessageFactory)`	Sets the `MessageFactory` object. This is the object used to create the SOAP message that is passed to the `onMessage` method.
`MimeHeaders getHeaders (HTTPRequest)`	Returns a `MimeHeaders` object that contains the headers in the given HTTPRequest object.
`void putHeaders (mimeHeaders, HTTPresponse)`	Sets the given `HTTPResponse` object with the headers in the given `MimeHeaders` object.
`onMessage (SOAPMesssage)`	User-defined method that is called by the servlet when the SOAP message is received. Normally this method needs to disassemble the SOAP message passed to it and to send a reply back to the client (if the servlet implements the `ReqRespListener` interface.)

Disassembling Messages

The `onMessage` method needs to disassemble the SOAP message that is passed to it by the servlet and process its contents in an appropriate manner. If there are problems in the processing of the message, the service needs to create a SOAP fault object and send it back to the client as described in Handling SOAP Faults.

Processing the SOAP message may involve working with the headers as well as locating the body elements and dealing with their contents. The following code sample shows how you might disassemble a SOAP message in the body of your `onMessage` method. Basically, you need to use a Document Object Model (DOM) API to parse through the SOAP message.

See `http://xml.coverpages.org/dom.html` for more information about the DOM API.

Example 6–4 Processing a SOAP Message

```
{http://xml.coverpages.org/dom.html
    SOAPEnvelope env = reply.getSOAPPart().getEnvelope();
    SOAPBody sb = env.getBody();
    // create Name object for XElement that we are searching for
    Name ElName = env.createName("XElement");

    //Get child elements with the name XElement
    Iterator it = sb.getChildElements(ElName);

    //Get the first matched child element.
    //We know there is only one.
    SOAPBodyElement sbe = (SOAPBodyElement) it.next();

    //Get the value for XElement
    MyValue =   sbe.getValue();
}
```

Handling Attachments

A SOAP message may have attachments. For sample code that shows you how to create and add an attachment, see Code Samples. For sample code that shows you how to receive and process an attachment, see Code Samples.

In handling attachments, you will need to use the Java Activation Framework API. See http://java.sun.com/products/javabeans/glasgow/jaf.html for more information.

Replying to Messages

In replying to messages, you are simply taking on the client role, now from the server side.

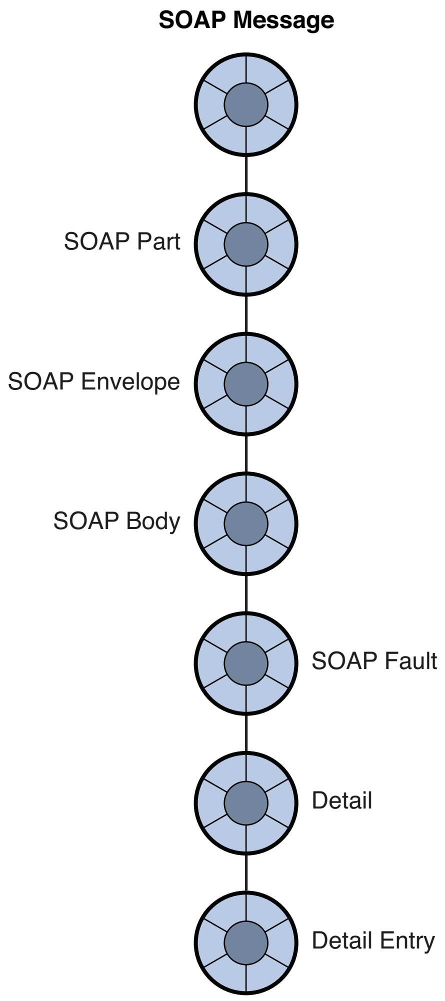
Handling SOAP Faults

Server-side code must use a SOAP fault object to handle errors that occur on the server side when unmarshalling the request, processing the message, or marshalling the response. The `SOAPFault` interface extends the `SOAPBodyElement` interface.

SOAP messages have a specific element and format for error reporting on the server side: a SOAP message body can include a SOAP fault element to report errors that happen during the processing of a request. Created on the server side and sent from the server back to the client, the SOAP message containing the `SOAPFault` object reports any unexpected behavior to the originator of the message.

Within a SOAP message object, the SOAP fault object is a child of the SOAP body, as shown in the figure below. Detail and detail entry objects are only needed if one needs to report that the body of the received message was malformed or contained inappropriate data. In such a case, the detail entry object is used to describe the malformed data.

Figure 6–8 SOAP Fault Element



The SOAP Fault element defines the following four sub-elements:

- `faultcode`

  A code (qualified name) that identifies the error. The code is intended for use by software to provide an algorithmic mechanism for identifying the fault. Predefined fault codes are listed in Table 6–3. This element is required.

- `faultstring`

  A string that describes the fault identified by the fault code. This element is intended to provide an explanation of the error that is understandable to a human. This element is required.

- `faultactor`

  A URI specifying the source of the fault: the actor that caused the fault along the message path. This element is not required if the message is sent to its final destination without going through any intermediaries. If a fault occurs at an intermediary, then that fault must include a `faultactor` element.

- `detail`

  This element carries specific information related to the Body element. It must be present if the contents of the Body element could not be successfully processed. Thus, if this element is missing, the client should infer that the body element was processed. While this element is not required for any error except a malformed payload, you can use it in other cases to supply additional information to the client.

Predefined Fault Codes The SOAP specification lists four predefined `faultcode` values. The namespace identifier for these is `http://schemas.xmlsoap.org/soap/envelope/`.

Table 6–3 SOAP Faultcode Values

Faultcode Name	Meaning
`VersionMismatch`	The processing party found an invalid namespace for the SOAP envelope element; that is, the namespace of the SOAP envelope element was not `http://schemas.xmlsoap.org/soap/envelope/`.
`MustUnderstand`	An immediate child element of the SOAP Header element was either not understood or not appropriately processed by the recipient. This element's `mustUnderstand` attribute was set to 1 (true).
`Client`	The message was incorrectly formed or did not contain the appropriate information. For example, the message did not have the proper authentication or payment information. The client should interpret this code to mean that the message must be changed before it is sent again. If this is the code returned, the `SOAPFault` object should probably include a `detailEntry` object that provides additional information about the malformed message.
`Server`	The message could not be processed for reasons that are not connected with its content. For example, one of the message handlers could not communicate with another message handler that was upstream and did not respond. Or, the database that the server needed to access is down. The client should interpret this error to mean that the transmission could succeed at a later point in time.

These standard fault codes represent classes of faults. You can extend these by appending a period to the code and adding an additional name. For example, you could define a `Server.OutOfMemory` code, a `Server.Down` code, and so forth.

Defining a SOAP Fault Using SAAJ you can specify the value for `faultcode`, `faultstring`, and `faultactor` using methods of the `SOAPFault` object. The following code creates a SOAP fault object and sets the `faultcode, faultstring,` and `faultactor` attributes:

```
SOAPFault fault;
reply = factory.createMessage();
envp = reply.getSOAPPart().getEnvelope(true);
someBody = envp.getBody();
fault = someBody.addFault():
fault.setFaultCode("Server");
fault.setFaultString("Some Server Error");
fault.setFaultActor(http://xxx.me.com/list/endpoint.esp/)
reply.saveChanges();
```

The server can return this object in its reply to an incoming SOAP message in case of a server error.

The next code sample shows how to define a detail and detail entry object. Note that you must create a name for the detail entry object.

```
SOAPFault fault = someBody.addFault();
fault.setFaultCode("Server");
fault.setFaultActor("http://foo.com/uri");
fault.setFaultString ("Unkown error");
Detail myDetail = fault.addDetail();
detail.addDetailEntry(envelope.createName("125detail", "m",
        "Someuri")).addTextNode("the message cannot contain
         the string //");
reply.saveChanges();
```

Integrating SOAP and Message Queue

This section explains how you can send, receive, and process a JMS message that contains a SOAP payload.

Message Queue provides a utility to help you send and receive SOAP messages using the JMS API. With the support it provides, you can convert a SOAP message into a JMS message and take advantage of the reliable messaging service offered by Message Queue. You can then convert the message back into a SOAP message on the receiving side and use SAAJ to process it.

To send, receive, and process a JMS message that contains a SOAP payload, you must do the following:

- Import the library `com.sun.messaging.xml.MessageTransformer` . This is the utility whose methods you will use to convert SOAP messages to JMS messages and vice versa.
- Before you transport a SOAP message, you must call the `MessageTransformer.SOAPMessageIntoJMSMessage` method. This method transforms the SOAP message into a JMS message. You then send the resulting JMS message as you would a normal JMS message. For programming simplicity, it would be best to select a destination that is dedicated to receiving SOAP messages. That is, you should create a particular queue or topic as a destination for your SOAP message and then send only SOAP messages to this destination.

  ```
  Message myMsg= MessageTransformer.SOAPMessageIntoJMSMessage
                               (SOAPMessage, Session);
  ```

  The `Session` argument specifies the session to be used in producing the `Message`.
- On the receiving side, you get the JMS message containing the SOAP payload as you would a normal JMS message. You then call the `MessageTransformer.SOAPMessageFromJMSMessage` utility to extract the SOAP message, and then use SAAJ to disassemble the SOAP message and do any further processing. For example, to obtain the SOAPMessage make a call like the following:

  ```
  SOAPMessage myMsg= MessageTransformer.SOAPMessageFromJMSMessage
                               (Message, MessageFactory);
  ```

  The `MessageFactory` argument specifies a message factory that the utility should use to construct the `SOAPMessage` from the given JMS `Message`.

The following sections offer several use cases and code examples to illustrate this process.

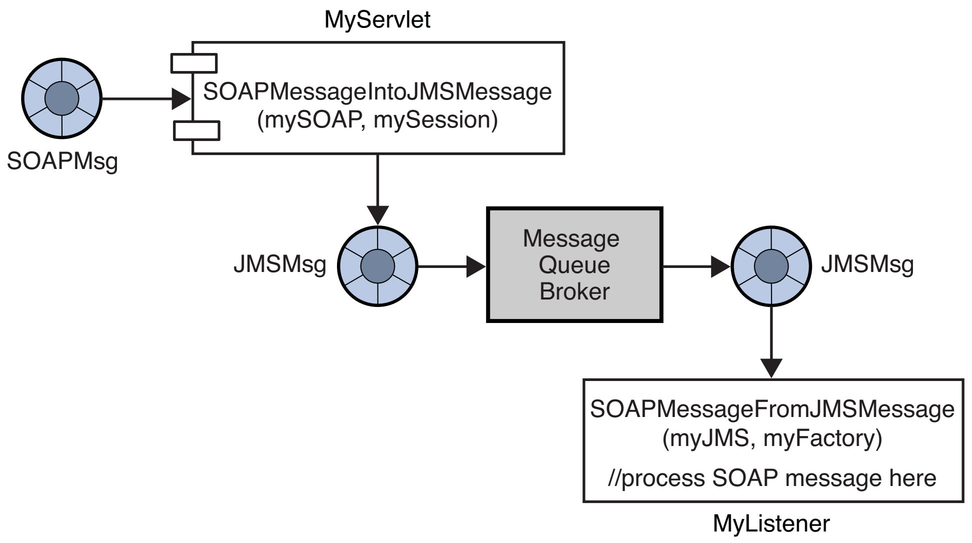
Example 1: Deferring SOAP Processing

In the first example, illustrated in Figure 6–9, an incoming SOAP message is received by a servlet. After receiving the SOAP message, the servlet `MyServlet` uses the

MessageTransformer utility to transform the message into a JMS message, and (reliably) forwards it to an application that receives it, turns it back into a SOAP message, and processes the contents of the SOAP message.

For information on how the servlet receives the SOAP message, see Writing a SOAP Service.

Figure 6–9 Deferring SOAP Processing



To Transform the SOAP Message into a JMS Message and Send the JMS Message

1. Instantiate a `ConnectionFactory` object and set its attribute values, for example:

```
QueueConnectionFactory myQConnFact =
        new com.sun.messaging.QueueConnectionFactory();
```

2. Use the `ConnectionFactory` object to create a `Connection` object.

```
QueueConnection myQConn =
         myQConnFact.createQueueConnection();
```

3. Use the `Connection` object to create a `Session` object.

```
QueueSession myQSess = myQConn.createQueueSession(false,
         Session.AUTO_ACKNOWLEDGE);
```

4. Instantiate a Message Queue Destination administered object corresponding to a physical destination in the Message Queue message service. In this example, the administered object is `mySOAPQueue` and the physical destination to which it refers is `myPSOAPQ`.

```
Queue mySOAPQueue = new com.sun.messaging.Queue("myPSOAPQ");
```

5. Use the `MessageTransformer` utility, as shown, to transform the SOAP message into a JMS message. For example, given a SOAP message named `MySOAPMsg`,

```
Message MyJMS = MessageTransformer.SOAPMessageIntoJMSMessage
                                       (MySOAPMsg, MyQSess);
```

6. Create a `QueueSender` message producer.

This message producer, associated with `mySOAPQueue`, is used to send messages to the queue destination named `myPSOAPQ`.

```
QueueSender myQueueSender = myQSess.createSender(mySOAPQueue);
```

7. Send a message to the queue.

```
myQueueSender.send(myJMS);
```

To Receive the JMS Message, Transform it into a SOAP Message, and Process It

1. Instantiate a `ConnectionFactory` object and set its attribute values.

```
QueueConnectioFactory myQConnFact = new
         com.sun.messaging.QueueConnectionFactory();
```

2. Use the `ConnectionFactory` object to create a `Connection` object.

```
QueueConnection myQConn = myQConnFact.createQueueConnection();
```

3. Use the `Connection` object to create one or more `Session` objects.

```
QueueSession myRQSess = myQConn.createQueueSession(false,
         session.AUTO_ACKNOWLEDGE);
```

4. Instantiate a `Destination` object and set its name attribute.

```
Queue myRQueue = new com.sun.messaging.Queue("mySOAPQ");
```

5. Use a `Session` object and a `Destination` object to create any needed `MessageConsumer` objects.

```
QueueReceiver myQueueReceiver =
     myRQSess.createReceiver(myRQueue);
```

6. If needed, instantiate a `MessageListener` object and register it with a `MessageConsumer` object.
7. Start the `QueueConnection` you created in Example 1: Deferring SOAP Processing. Messages for consumption by a client can only be delivered over a connection that has been started.

```
myQConn.start();
```

8. Receive a message from the queue.

   The code below is an example of a synchronous consumption of messages:

```
Message myJMS = myQueueReceiver.receive();
```

9. Use the Message Transformer to convert the JMS message back to a SOAP message.

```
SOAPMessage MySoap =
         MessageTransformer.SOAPMessageFromJMSMessage
             (myJMS, MyMsgFactory);
```

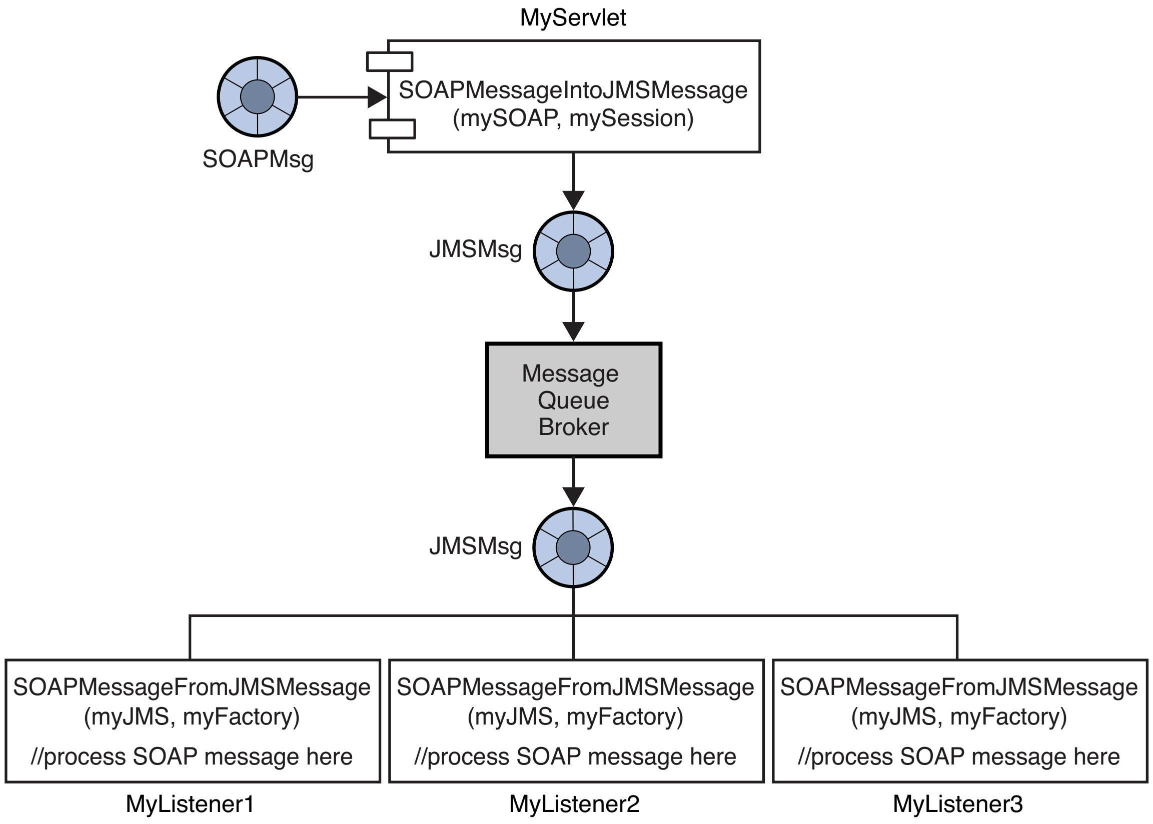
   If you specify null for the `MessageFactory` argument, the default Message Factory is used to construct the SOAP Message.

10. Disassemble the SOAP message in preparation for further processing. See The SOAP Message Object for information.

Example 2: Publishing SOAP Messages

In the next example, illustrated in Figure 6–10, an incoming SOAP message is received by a servlet. The servlet packages the SOAP message as a JMS message and (reliably) forwards it to a topic. Each application that subscribes to this topic, receives the JMS message, turns it back into a SOAP message, and processes its contents.

Figure 6–10 Publishing a SOAP Message


MyServlet
SOAPMessageIntoJMSMessage
(mySOAP, mySession)
SOAPMsg
JMSMsg
Message
Queue
Broker
JMSMsg
SOAPMessageFromJMSMessage
(myJMS, myFactory)
//process SOAP message here
MyListener1
SOAPMessageFromJMSMessage
(myJMS, myFactory)
//process SOAP message here
MyListener2
SOAPMessageFromJMSMessage
(myJMS, myFactory)
//process SOAP message here
MyListener3

The code that accomplishes this is exactly the same as in the previous example, except that instead of sending the JMS message to a queue, you send it to a topic. For an example of publishing a SOAP message using Message Queue, see Example 6–5.

Code Samples

This section includes and describes two code samples: one that sends a JMS message with a SOAP payload, and another that receives the JMS/SOAP message and processes the SOAP message.

Example 6–5 illustrates the use of the JMS API, the SAAJ API, and the JAF API to send a SOAP message with attachments as the payload to a JMS message. The code shown for the `SendSOAPMessageWithJMS` includes the following methods:

- A constructor that calls the `init` method to initialize all the JMS objects required to publish a message
- A `send` method that creates the SOAP message and an attachment, converts the SOAP message into a JMS message, and publishes the JMS message
- A `close` method that closes the connection
- A `main` method that calls the send and close methods

Example 6–5 Sending a JMS Message with a SOAP Payload

```
//Libraries needed to build SOAP message
import javax.xml.soap.SOAPMessage;
import javax.xml.soap.SOAPPart;
import javax.xml.soap.SOAPEnvelope;
import javax.xml.soap.SOAPBody;
import javax.xml.soap.SOAPElement;
import javax.xml.soap.MessageFactory;
import javax.xml.soap.AttachmentPart;
import javax.xml.soap.Name

//Libraries needed to work with attachments (Java Activation Framework API)
import java.net.URL;
import javax.activation.DataHandler;

//Libraries needed to convert the SOAP message to a JMS message and to send it
import com.sun.messaging.xml.MessageTransformer;
import com.sun.messaging.BasicConnectionFactory;

//Libraries needed to set up a JMS connection and to send a message
import javax.jms.TopicConnectionFactory;
import javax.jms.TopicConnection;
import javax.jms.JMSException;
import javax.jms.Session;
import javax.jms.Message;
import javax.jms.TopicSession;
import javax.jms.Topic;
import javax.jms.TopicPublisher;

//Define class that sends JMS message with SOAP payload
public class SendSOAPMessageWithJMS{

    TopicConnectionFactory tcf = null;
    TopicConnection tc = null;
    TopicSession session = null;
    Topic topic = null;
    TopicPublisher publisher = null;

//default constructor method
public SendSOAPMessageWithJMS(String topicName){
    init(topicName);
    }

//Method to nitialize JMS Connection, Session, Topic, and Publisher
public void init(String topicName) {
    try {
        tcf = new com.sun.messaging.TopicConnectionFactory();
        tc = tcf.createTopicConnection();
        session = tc.createTopicSession(false, Session.AUTO_ACKNOWLEDGE);
        topic = session.createTopic(topicName);
        publisher = session.createPublisher(topic);
        }

//Method to create and send the SOAP/JMS message
public void send() throws Exception{
    MessageFactory mf = MessageFactory.newInstance(); //create default factory
    SOAPMessage soapMessage=mfcreateMessage(); //create SOAP message object
    SOAPPart soapPart = soapMessage.getSOAPPart();//start to drill down to body
    SOAPEnvelope soapEnvelope = soapPart.getEnvelope(); //first the envelope
    SOAPBody soapBody = soapEnvelope.getBody();
    Name myName = soapEnvelope.createName("HelloWorld", "hw",
                                 http://www.sun.com/imq');
                                                 //name for body element
    SOAPElement element = soapBody.addChildElement(myName); //add body element
    element.addTextNode("Welcome to SUnOne Web Services."); //add text value

    //Create an attachment with the Java Framework Activation API
    URL url = new URL("http://java.sun.com/webservices/");
    DataHandler dh = new DataHnadler (url);
    AttachmentPart ap = soapMessage.createAttachmentPart(dh);

    //Set content type and ID
    ap.setContentType("text/html");
    ap.setContentID('cid-001");

    //Add attachment to the SOAP message
    soapMessage.addAttachmentPart(ap);
    soapMessage.saveChanges();

    //Convert SOAP to JMS message.
    Message m = MessageTransformer.SOAPMessageIntoJMSMessage
                                                 (soapMessage,session);

//Publish JMS message
    publisher.publish(m);

//Close JMS connection
    public void close() throws JMSException {
        tc.close();
    }

//Main program to send SOAP message with JMS
public static void main (String[] args) {
    try {
        String topicName = System.getProperty("TopicName");
        if(topicName == null) {
            topicName = "test";
        }

        SendSOAPMEssageWithJMS ssm = new SendSOAPMEssageWithJMS(topicName);
        ssm.send();
        ssm.close();
    }
        catch (Exception e) {
            e.printStackTrace();
        }
    }
}
```

Example 6–6 illustrates the use of the JMS API, SAAJ, and the DOM API to receive a SOAP message with attachments as the payload to a JMS message. The code shown for the `ReceiveSOAPMessageWithJMS` includes the following methods:

- A constructor that calls the `init` method to initialize all the JMS objects needed to receive a message.
- An `onMessage` method that delivers the message and which is called by the listener. The `onMessage` method also calls the message transformer utility to convert the JMS message into a SOAP message and then uses SAAJ to process the SOAP body and uses SAAJ and the DOM API to process the message attachments.

- A `main` method that initializes the `ReceiveSOAPMessageWithJMS` class.

Example 6–6 Receiving a JMS Message with a SOAP Payload

```
//Libraries that support SOAP processing
import javax.xml.soap.MessageFactory;
import javax.xml.soap.SOAPMessage;
import javax.xml.soap.AttachmentPart

//Library containing the JMS to SOAP transformer
import com.sun.messaging.xml.MessageTransformer;

//Libraries for JMS messaging support
import com.sun.messaging.TopicConnectionFactory

//Interfaces for JMS messaging
import javax.jms.MessageListener;
import javax.jms.TopicConnection;
import javax.jms.TopicSession;
import javax.jms.Message;
import javax.jms.Session;
import javax.jms.Topic;
import javax.jms.JMSException;
import javax.jms.TopicSubscriber

//Library to support parsing attachment part (from DOM API)
import java.util.iterator;

public class ReceiveSOAPMessageWithJMS implements MessageListener{
    TopicConnectionFactory tcf = null;
    TopicConnection tc = null;
    TopicSession session = null;
    Topic topic = null;
    TopicSubscriber subscriber = null;
    MessageFactory messageFactory = null;

//Default constructor
public ReceiveSOAPMessageWithJMS(String topicName) {
    init(topicName);
}
//Set up JMS connection and related objects
public void init(String topicName){
    try {
        //Construct default SOAP message factory
        messageFactory = MessageFactory.newInstance();

        //JMS set up
        tcf = new. com.sun.messaging.TopicConnectionFactory();
        tc = tcf.createTopicConnection();
        session = tc.createTopicSesstion(false, Session.AUTO_ACKNOWLEDGE);
        topic = session.createTopic(topicName);
        subscriber = session.createSubscriber(topic);
        subscriber.setMessageListener(this);
        tc.start();

        System.out.println("ready to receive SOAP m essages...");
    }catch (Exception jmse){
        jmse.printStackTrace();
        }
    }
//JMS messages are delivered to the onMessage method
public void onMessage(Message message){
    try {
        //Convert JMS to SOAP message
        SOAPMessage soapMessage = MessageTransformer.SOAPMessageFromJMSMessage
                            (message, messageFactory);


        //Print attchment counts
        System.out.println("message received! Attachment counts:
                             " + soapMessage.countAttachments());

        //Get attachment parts of the SOAP message
        Iterator iterator = soapMessage.getAttachments();
        while (iterator.hasNext()) {
            //Get next attachment
            AttachmentPart ap = (AttachmentPart) iterator.next();

            //Get content type
            String contentType = ap.getContentType();
            System.out.println("content type: " + conent TYpe);

            //Get content id
            String contentID = ap.getContentID();
            System.out.println("content Id:" + contentId);

            //Check to see if this is text
            if(contentType.indexOf"text")>=0 {
                //Get and print string content if it is a text attachment
                String content = (String) ap.getContent();
                System.outprintln("*** attachment content: " + content);
            }
        }
    }catch (Exception e) {
        e.printStackTrace();
    }
}

//Main method to start sample receiver
public static void main (String[] args){
    try {
        String topicName = System.getProperty("TopicName");
        if( topicName == null) {
            topicName = "test";
        }
        ReceiveSOAPMessageWithJMS rsm = new ReceiveSOAPMessageWithJMS(topicName);
    }catch (Exception e) {
        e.printStackTrace();
        }
    }
}
```

7

Embedding a Message Queue Broker in a Java Client

Message Queue supports running a broker from within a Java client. Such a broker, called an *embedded broker*, runs in the same JVM as the Java client that creates and starts it.

Beyond operating like a normal standalone broker, an embedded broker offers the application in which it is embedded access to a special kind of connection called a *direct mode connection*. Direct mode connections are used just like ordinary connections, but they are much higher performing because they use in-memory transport instead of TCP. To specify a direct mode connection, the client specifies `mq://localhost/direct` as the broker address in the connection factory from which it subsequently creates the connection.

The following sections provide more information about creating and managing embedded brokers:

- Creating, Initializing and Starting an Embedded Broker
- Creating a Direct Connection to an Embedded Broker
- Creating a TCP Connection to an Embedded Broker
- Stopping and Shutting Down an Embedded Broker
- Embedded Broker Example

Creating, Initializing and Starting an Embedded Broker

To create, initialize, and start an embedded broker, you:

1. Create a broker instance in the client runtime.
2. Create a broker event listener.
3. Define properties to use when initializing the broker instance.
4. Initialize the broker instance.
5. Start the broker instance.

The following listing shows an example of creating, initializing, and starting an Embedded Broker. In this example, *args* represents the string of arguments to pass as properties when initializing the broker instance, and *EmbeddedBrokerEventListener* is an existing class that implements the `BrokerEventListener` interface.

```
import com.sun.messaging.jmq.jmsclient.runtime.BrokerInstance;
import com.sun.messaging.jmq.jmsclient.runtime.ClientRuntime;
import com.sun.messaging.jmq.jmsservice.BrokerEvent;
import com.sun.messaging.jmq.jmsservice.BrokerEventListener;

// Obtain the ClientRuntime singleton object
ClientRuntime clientRuntime = ClientRuntime.getRuntime();

// Create a broker instance
BrokerInstance brokerInstance = clientRuntime.createBrokerInstance();

// Create a broker event listener
BrokerEventListener listener = new EmbeddedBrokerEventListener();

// Convert the broker arguments into Properties. Note that parseArgs is
// a utility method that does not change the broker instance.
Properties props = brokerInstance.parseArgs(args);

// Initialize the broker instance using the specified properties and
// broker event listener
brokerInstance.init(props, listener);

// now start the embedded broker
brokerInstance.start();
```

Creating a Broker Event Listener

When initializing an embedded broker, you must provide a broker event listener. This listener is an instance of a class that implements the `BrokerEventListener` interface. This interface specifies two methods:

- `public void brokerEvent(BrokerEvent brokerEvent)`, which is called when the broker starts and stops. This method is not required to perform any specific actions, so you can implement an empty method.
- `public boolean exitRequested(BrokerEvent event, Throwable thr)`, which is called when the embedded broker is about to shut down, either because of a user command or because of a fatal error. This method is not required to perform any specific actions, so you can implement an empty method. The return value is ignored.

The following listing shows an example class that implements the `BrokerEventListener` interface.

```
class EmbeddedBrokerEventListener implements BrokerEventListener {

    public void brokerEvent(BrokerEvent brokerEvent) {
        System.out.println ("Received broker event:"+brokerEvent);
    }

    public boolean exitRequested(BrokerEvent event, Throwable thr) {
        System.out.println ("Broker is about to shut down because of:"+event+"
with "+thr);
        // return value will be ignored
        return true;
    }
}
```

Arguments to Specify When Initializing an Embedded Broker

When initializing an embedded broker, you can provide a list of arguments as properties.

Because a Java client runtime (not the `imqbrokerd` utility) is initializing the broker, you should specify these arguments:

`-imqhome` ***path***
The home directory of the Message Queue installation (see "Directory Variable Conventions").

`-libhome` ***path***
The directory in which Message Queue libraries are stored, `IMQ_HOME/lib`.

`-varhome` ***path***
The directory in which Message Queue temporary or dynamically created configuration and data files are stored installation (see "Directory Variable Conventions").

You can also specify `imqbrokerd` options as arguments. Two useful options to specify as arguments are:

`-name` ***instanceName***
The instance name of the broker.

`-port` ***portNumber***
The port number for the broker's Port Mapper. This is port number on which the broker listens for client connections.

Creating a Direct Connection to an Embedded Broker

Once an embedded broker has been started, you can create direct connections to it from the client in which it is embedded. To do so, you create a connection as you would with an ordinary broker, but you specify `mq://localhost/direct` as broker address in the connection factory. For example:

```
com.sun.messaging.ConnectionFactory cf = new
com.sun.messaging.ConnectionFactory();
cf.setProperty(ConnectionConfiguration.imqAddressList, "mq://localhost/direct" );
Connection connection = cf.createConnection();
```

Creating a TCP Connection to an Embedded Broker

Once an embedded broker has been started, clients other than the one in which it is embedded can connect to it as though it were an ordinary standalone broker. For example:

```
com.sun.messaging.ConnectionFactory cf = new
com.sun.messaging.ConnectionFactory();
cf.setProperty(ConnectionConfiguration.imqAddressList,
"mq://myhost.example.com:7676" );
Connection connection = cf.createConnection();
```

Stopping and Shutting Down an Embedded Broker

To stop and shut down an embedded broker, use the stop() and shutdown() methods of the broker instance. For example:

```
// Stop the embedded broker
brokerInstance.stop();
// Shut down the embedded broker
brokerInstance.shutdown();
```

Embedded Broker Example

The following listing demonstrates how to:

- Create, initialize and start an embedded broker
- Create a direct connection
- Send and receive messages across a direct connection
- Stop and shut down an embedded broker
- Create a broker event listener

```
package test.direct;

import java.util.Properties;

import javax.jms.Connection;
import javax.jms.Message;
import javax.jms.MessageConsumer;
import javax.jms.MessageProducer;
import javax.jms.Queue;
import javax.jms.Session;
import javax.jms.TextMessage;

import com.sun.messaging.ConnectionConfiguration;
import com.sun.messaging.jmq.jmsclient.runtime.BrokerInstance;
import com.sun.messaging.jmq.jmsclient.runtime.ClientRuntime;
import com.sun.messaging.jmq.jmsservice.BrokerEvent;
import com.sun.messaging.jmq.jmsservice.BrokerEventListener;

public class EmbeddedBrokerExample {

    public void run(String[] args) throws Exception{

        // obtain the ClientRuntime singleton object
        ClientRuntime clientRuntime = ClientRuntime.getRuntime();

        // create the embedded broker instance
        BrokerInstance brokerInstance = clientRuntime.createBrokerInstance();

        // convert the specified broker arguments into Properties
        // this is a utility function: it doesn't change the broker
        Properties props = brokerInstance.parseArgs(args);

        // initialise the broker instance
        // using the specified properties
        // and a BrokerEventListener
        BrokerEventListener listener = new ExampleBrokerEventListener();
        brokerInstance.init(props, listener);
        // now start the embedded broker
        brokerInstance.start();

        System.out.println ("Embedded broker started");

        // now create a direct connection to the embedded broker
        // this is identical to a normal TCP connection except that a special URL
is used
        com.sun.messaging.ConnectionFactory qcf = new
com.sun.messaging.ConnectionFactory();
        qcf.setProperty(ConnectionConfiguration.imqAddressList,
"mq://localhost/direct");

        Connection connection = qcf.createConnection();
        System.out.println ("Created direct connection to embedded broker");

        // now create a session and a producer and consumer in the normal way
        Session session = connection.createSession(false, Session.AUTO_
ACKNOWLEDGE);
        Queue queue = session.createQueue("exampleQueue");
        MessageConsumer consumer = session.createConsumer(queue);
        MessageProducer producer = session.createProducer(queue);

        // send a message to the queue in the normal way
        TextMessage textMessage = session.createTextMessage("This is a message");
        producer.send(textMessage);

        // receive a message from the queue in the normal way
        connection.start();
        Message receivedMessage = consumer.receive(1000);
        System.out.println ("Received message
"+((TextMessage)receivedMessage).getText());

        // close the client connection
        connection.close();

        // stop the embedded broker
        brokerInstance.stop();

        // shutdown the embedded broker
        brokerInstance.shutdown();

    }

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

        EmbeddedBrokerExample ebe = new EmbeddedBrokerExample();
        ebe.run(args);

    }

    class ExampleBrokerEventListener implements BrokerEventListener {

        public void brokerEvent(BrokerEvent brokerEvent) {
            System.out.println ("Received broker event:"+brokerEvent);
        }

        public boolean exitRequested(BrokerEvent event, Throwable thr) {
            System.out.println ("Broker is about to shut down because of:"+event+"
with "+thr);

            // return value will be ignored
            return true;
        }
    }
}
```

A

Warning Messages and Client Error Codes

This appendix provides reference information for warning messages and for error codes returned by the Message Queue client runtime when it raises a JMS exception.

- A *warning message* is a message output when the Message Queue Java client runtime experiences a problem that should not occur under normal operating conditions. The message is displayed where the application displays its output. Usually, this is the window from which the application is started. Table A–1 lists Message Queue warning messages.

  In general, a warning message does not cause message loss or affect reliability. issues. But when warning messages appear constantly on the application's console, the user should contact Message Queue technical support to diagnose the cause of the warning messages.

- *Error codes* and messages are returned by the client runtime when it raises an exception. You can obtain the error code and its corresponding message using the `JMSException.getErrorCode()` method and the `JMSException.getMessage()` method. Table A–2 lists Message Queue error codes.

Note that warning messages and error codes are not defined in the JMS specification, but are specific to each JMS provider. Applications that rely on these error codes in their programming logic are not portable across JMS providers.

Warning Messages and Error Codes

Table A–1 Message Queue Warning Message Codes

Code	Message and Description
W2000	**Message** Warning: Received unknown packet: *mq-packet-dump*. **Cause** The Message Queue client runtime received an unrecognized Message Queue packet, where *mq-packet-dump* is replaced with the specific Message Queue packet dump that caused this warning message. The Message Queue broker may not be fully compatible with the client runtime version.
W2001	**Message** Warning: pkt not processed, no message consumer:*mq-packet-dump.* **Cause** The Message Queue client runtime received an unexpected Message Queue acknowledge message. The variable *mq-packet-dump* is replaced with the specific Message Queue packet dump that caused this warning message.

Table A–1 (Cont.) Message Queue Warning Message Codes

Code	Message and Description
W2003	**Message** Warning: Broker not responding *X* for *Y* seconds. Still trying.... **Cause** The Message Queue client runtime has not received a response from the broker for more than 2 minutes (default). In the actual message, the *X* variable is replaced with the Message Queue packet type that the client runtime is waiting for, and the *Y* variable is replaced with the number of seconds that the client runtime has been waiting for the packet.

Table A–2 lists the error codes in numerical order. For each code listed, it supplies the error message and a probable cause.

Each error message returned has the following format:

```
[Code]: "Message -cause Root-cause-exception-message
."
```

Message text provided for `-cause` is only appended to the message if there is an exception linked to the JMS exception. For example, a JMS exception with error code `C4003` returns the following error message:

```
[C4003]: Error occurred on connection creation [localhost:7676]
 - cause: java.net.ConnectException: Connection refused: connect
```

Table A–2 Message Queue Client Error Codes

Code	Message and Description
C4000	**Message** Packet acknowledge failed. **Cause** The client runtime was not able to receive or process the expected acknowledgment sent from the broker.
C4001	**Message** Write packet failed. **Cause** The client runtime was not able to send information to the broker. This might be caused by an underlying network I/O failure or by the JMS connection being closed.
C4002	**Message** Read packet failed. **Cause** The client runtime was not able to process inbound message properly. This might be caused by an underlying network I/O failure.
C4003	**Message** Error occurred on connection creation [host, port]. **Cause** The client runtime was not able to establish a connection to the broker with the specified host name and port number.
C4004	**Message** An error occurred on connection close. **Cause** The client runtime encountered one or more errors when closing the connection to the broker.
C4005	**Message** Get properties from packet failed. **Cause** The client runtime was not able to retrieve a property object from the Message Queue packet.
C4006	**Message** Set properties to packet failed. **Cause** The client runtime was not able to set a property object in the Message Queue packet.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4007	**Message** Durable subscription {0} in use. *{0} is replaced with the subscribed destination name.* **Cause** The client runtime was not able to unsubscribe the durable subscriber because it is currently in use by another consumer.
C4008	**Message** Message in read-only mode. **Cause** An attempt was made to write to a JMS Message that is in read-only mode.
C4009	**Message** Message in write-only mode. **Cause** An attempt was made to read a JMS Message that is in write-only mode.
C4010	**Message** Read message failed. **Cause** The client runtime was not able to read the stream of bytes from a `BytesMessage` type message.
C4011	**Message** Write message failed. **Cause** The client runtime was not able to write the stream of bytes to a `BytesMessage` type message.
C4012	**Message** message failed. **Cause** The client runtime encountered an error when processing the `reset()` method for a `BytesMessage` or `StreamMessage` type message.
C4013	**Message** Unexpected end of stream when reading message. **Cause** The client runtime reached end-of-stream when processing the readXXX() method for a `BytesMessage` or `StreamMessage` type message.
C4014	**Message** Serialize message failed. **Cause** The client runtime encountered an error when processing the serialization of an object, such as `ObjectMessage.setObject(java.io.Serializable object).`
C4015	**Message** Deserialize message failed. **Cause** The client runtime encountered an error when processing the deserialization of an object, for example, when processing the method `ObjectMessage.getObject().`
C4016	**Message** Error occurred during message acknowledgment. **Cause** The client runtime encountered an error during the process of message acknowledgment in a session.
C4017	**Message** Invalid message format. **Cause** The client runtime encountered an error when processing a JMS Message; for example, during data type conversion.
C4018	**Message** Error occurred on request message redeliver. **Cause** The client runtime encountered an error when processing `recover()` or `rollback()` for the JMS session.
C4019	**Message** Destination not found: {0}. *{0} is replaced with the destination name specified in the API parameter.* **Cause** The client runtime was unable to process the API request due to an invalid destination specified in the API, for example, the call `MessageProducer.send (null, message)` raises `JMSException` with this error code and message.
C4020	**Message** Temporary destination belongs to a closed connection or another connection - {0}. *{0} is replaced with the temporary destination name specified in the API parameter.* **Cause** An attempt was made to use a temporary destination that is not valid for the message producer.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4021	**Message** Consumer not found. **Cause** The Message Queue session could not find the message consumer for a message sent from the broker. The message consumer may have been closed by the application or by the client runtime before the message for the consumer was processed.
C4022	**Message** Selector invalid: {0}. *{0} is replaced with the selector string specified in the API parameter.* **Cause** The client runtime was unable to process the JMS API call because the specified selector is invalid.
C4023	**Message** Client unacknowledged messages over system defined limit. **Cause** The client runtime raises a `JMSException` with this error code and message if unacknowledged messages exceed the system defined limit in a `CLIENT_ACKNOWLEDGE` session.
C4024	**Message** The session is not transacted. **Cause** An attempt was made to use a transacted session API in a non-transacted session. For example, calling the methods `commit()` or `rollback` in a `AUTO_ ACKNOWLEDGE` session.
C4025	**Message** Cannot call this method from a transacted session. **Cause** An attempt was made to call the `Session.recover()` method from a transacted session.
C4026	**Message** Client non-committed messages over system defined limit. **Cause** The client runtime raises a `JMSException` with this error code and message if non committed messages exceed the system-defined limit in a transacted session.
C4027	**Message** Invalid transaction ID: {0}. *{0} is replaced with the internal transaction ID.* **Cause** An attempt was made to commit or rollback a transacted session with a transaction ID that is no longer valid.
C4028	**Message** Transaction ID {0} in use. *{0} is replaced with the internal transaction ID.* **Cause** The internal transaction ID is already in use by the system. An application should not receive a `JMSException` with this error code under normal operations.
C4029	**Message** Invalid session for `ServerSession.` **Cause** An attempt was made to use an invalid JMS session for the `ServerSession` object, for example, no message listener was set for the session.
C4030	**Message** Illegal `maxMessages` value for `ServerSession:` {0}. *{0} was replaced with* `maxMessages` *value used by the application.* **Cause** The configured `maxMessages` value for `ServerSession` is less than 0.
C4031	**Message** `MessageConsumer` and `ServerSession` session conflict. **Cause** An attempt was made to create a message consumer for a session already used by a `ServerSession` object.
C4032	**Message** Can not use`receive()` when message listener was set. **Cause** An attempt was made to do a synchronous receive with an asynchronous message consumer.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4033	**Message** Authentication type does not match: {0} and {1}. *{0} is replaced with the authentication type used by the client runtime. {1} is replaced with the authentication type requested by the broker.* **Cause** The authentication type requested by the broker does not match the authentication type in use by the client runtime.
C4034	**Message** Illegal authentication state. **Cause** The authentication handshake failed between the client runtime and the broker.
C4035	**Message** Received `AUTHENTICATE_REQUEST` status code `FORBIDDEN`. **Cause** The client runtime authentication to the broker failed.
C4036	**Message** A broker error occurred. **Cause** A generic error code indicating that the client's requested operation to the broker failed.
C4037	**Message** Broker unavailable or broker timeout. **Cause** The client runtime was unable to establish a connection to the broker.
C4038	**Message** [4038] - cause: {0} *{0} is replaced with a root cause exception message.* **Cause** The client runtime caught an exception thrown from the JVM. The client runtime throws `JMSException` with the "root cause exception" set as the linked exception.
C4039	**Message** Cannot delete destination. **Cause** The client runtime was unable to delete the specified temporary destination. See `TemporaryTopic.delete()` and `TemporaryQueue.delete()` API Javadoc for constraints on deleting a temporary destination.
C4040	**Message** Invalid ObjectProperty type. **Cause** An attempt was made to set a non-primitive Java object as a JMS message property. Please see `Message.setObjectProperty()` API Javadoc for valid object property types.
C4041	**Message** Reserved word used as property name - {0}. *{0} is replaced with the property name.* **Cause** An attempt was made to use a reserved word, defined in the JMS Message API Javadoc, as the message property name, for example, `NULL`, `TRUE`, `FALSE`.
C4042	**Message** Illegal first character of property name - {0} *{0} is replaced with the illegal character.* **Cause** An attempt was made to use a property name with an illegal first character. See JMS Message API Javadoc for valid property names.
C4043	**Message** Illegal character used in property name - {0} *{0} is replaced with the illegal character used.* **Cause** An attempt was made to use a property name containing an illegal character. See JMS Message API Javadoc for valid property names.
C4044	**Message** Browser timeout. **Cause** The queue browser was unable to return the next available message to the application within the system's predefined timeout period.
C4045	**Message** No more elements. **Cause** In `QueueBrowser`, the enumeration object has reached the end of element but `nextElement()` is called by the application.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4046	**Message** Browser closed. **Cause** An attempt was made to use `QueueBrowser` methods on a closed `QueueBrowser` object.
C4047	**Message** Operation interrupted. **Cause** `ServerSession` was interrupted. The client runtime throws `RuntimeException` with the above exception message when it is interrupted in the `ServerSession`.
C4048	**Message** ServerSession is in progress. **Cause** Multiple threads attempted to operate on a server session concurrently.
C4049	**Message** Can not call Connection.close(), stop(), etc from message listener. **Cause** An attempt was made to call `Connection.close(),...stop()`, etc from a message listener.
C4050	**Message** Invalid destination name - {0} . *{0} is replaced with the invalid destination name used* **Cause** An attempt was made to use an invalid destination name, for example, `NULL`.
C4051	**Message** Invalid delivery parameter. {0} : {1} *{0} is replaced with delivery parameter name, such as "DeliveryMode".{1} is replaced with delivery parameter value used by the application.* **Cause** An attempt was made to use invalid JMS delivery parameters in the API, for example, values other than `DeliveryMode.NON_PERSISTENT` or `DeliveryMode.PERSISTENT` were used to specify the delivery mode.
C4052	**Message** Client ID is already in use - {0} *{0} is replaced with the client ID that is already in use.* **Cause** An attempt was made to set a client ID to a value that is already in use by the system.
C4053	**Message** Invalid client ID - {0} *{0} is replaced with the client ID used by the application.* **Cause** An attempt was made to use an invalid client ID, for example, `null` or empty client ID.
C4054	**Message** Can not set client ID, invalid state. **Cause** An attempt was made to set a connection's client ID at the wrong time or when it has been administratively configured.
C4055	**Message** Resource in conflict. Concurrent operations on a session. **Cause** An attempt was made to concurrently operate on a session with multiple threads.
C4056	**Message** Received goodbye message from broker. **Cause** A Message Queue client received a `GOOD_BYE` message from broker.
C4057	**Message** No username or password. **Cause** An attempt was made to use a null object as a user name or password for authentication.
C4058	**Message** Cannot acknowledge message for closed consumer. **Cause** An attempt was made to acknowledge message(s) for a closed consumer.
C4059	**Message** Cannot perform operation, session is closed. **Cause** An attempt was made to call a method on a closed session.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4060	**Message** Login failed: {0} *{0} message is replaced with user name.* **Cause** Login with the specified user name failed.
C4061	**Message** Connection recovery failed, cannot recover connection. **Cause** The client runtime was unable to recover the connection due to internal error.
C4062	**Message** Cannot perform operation, connection is closed. **Cause** An attempt was made to call a method on a closed connection.
C4063	**Message** Cannot perform operation, consumer is closed. **Cause** An attempt was made to call a method on a closed message consumer.
C4064	**Message** Cannot perform operation, producer is closed. **Cause** An attempt was made to call a method on a closed message producer.
C4065	**Message** Incompatible broker version encountered. Client version {0}.Broker version {1} *{0} is replaced with client version number. {1} is replaced with broker version number.* **Cause** An attempt was made to connect to a broker that is not compatible with the client version.
C4066	**Message** Invalid or empty Durable Subscription Name was used: {0} *{0} is replaced with the durable subscription name used by the application.* **Cause** An attempt was made to use a null or empty string to specify the name of a durable subscription.
C4067	**Message** Invalid session acknowledgment mode: {0} *{0} is replaced with the acknowledge mode used by the application.* **Cause** An attempt was made to use a non-transacted session mode that is not defined in the JMS Session API.
C4068	**Message** Invalid Destination Classname: {0}. *{0} is replaced with the name of the class name.* **Cause** An attempt was made to create a message producer or message consumer with an invalid destination class type. The valid class type must be either `Queue` or `Topic`.
C4069	**Message** Cannot commit or rollback on an XASession. **Cause** The application tried to make a `session.commit()` or a `session.rollback()` call in an application server component whose transactions are being managed by the Transaction Manager using the XAResource. These calls are not allowed in this context.
C4070	**Message** Error when converting foreign message. **Cause** The client runtime encountered an error when processing a non-Message Queue JMS message.
C4071	**Message** Invalid method in this domain: {0} *{0} is replaced with the method name used.* **Cause** An attempt was made to use a method that does not belong to the current messaging domain. For example calling `TopicSession.createQueue()` will raise a `JMSException` with this error code and message.
C4072	**Message** Illegal property name - "" or null. **Cause** An attempt was made to use a null or empty string to specify a property name.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4073	**Message** A JMS destination limit was reached. Too many Subscribers/Receivers for {0} : {1} *{0} is replaced with "Queue" or "Topic" {1} is replaced with the destination name.* **Cause** The client runtime was unable to create a message consumer for the specified domain and destination due to a broker resource constraint.
C4074	**Message** Transaction rolled back due to provider connection failover. **Cause** An attempt was made to call `Session.commit()` after connection failover occurred. The transaction is rolled back automatically.
C4075	**Message** Cannot acknowledge messages due to provider connection failover. Subsequent acknowledge calls will also fail until the application calls `session.recover()`. **Cause** As stated in the message.
C4076	**Message** Client does not have permission to create producer on destination: {0} *{0} is replaced with the destination name that caused the exception.* **Cause** The application client does not have permission to create a message producer with the specified destination.
C4077	**Message** Client is not authorized to create destination : {0} *{0} is replaced with the destination name that caused the exception.* **Cause** The application client does not have permission to create the specified destination.
C4078	**Message** Client is unauthorized to send to destination: {0} *{0} is replaced with the destination name that caused the exception.* **Cause** The application client does not have permission to produce messages to the specified destination.
C4079	**Message** Client does not have permission to register a consumer on the destination: {0} *{0} is replaced with the destination name that caused the exception.* **Cause** The application client does not have permission to create a message consumer with the specified destination name.
C4080	**Message** Client does not have permission to delete consumer: {0} *{0} is replaced with the consumer ID for the consumer to be deleted.* **Cause** The application does not have permission to remove the specified consumer from the broker.
C4081	**Message** Client does not have permission to unsubscribe: {0} *{0} was replaced with the name of the subscriber to unsubscribe.* **Cause** The client application does not have permission to unsubscribe the specified durable subscriber.
C4082	**Message** Client is not authorized to access destination: {0} *{0} is replaced with the destination name that caused the exception.* **Cause** The application client is not authorized to access the specified destination.
C4083	**Message** Client does not have permission to browse destination: {0} *{0} is replaced with the destination name that caused the exception.* **Cause** The application client does not have permission to browse the specified destination.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4084	**Message** User authentication failed: {0} *{0} is replaced with the user name.* **Cause** User authentication failed.
C4085	**Message** Delete consumer failed. Consumer was not found: {0} *{0} is replaced with name of the consumer that could not be found.* **Cause** The attempt to close a message consumer failed because the broker was unable to find the specified consumer.
C4086	**Message** Unsubscribe failed. Subscriber was not found: {0} *{0} is replaced with name of the durable subscriber.* **Cause** An attempt was made to unsubscribe a durable subscriber with a name that does not exist in the system.
C4087	**Message** Set Client ID operation failed. Invalid Client ID: {0} *{0} is replaced with the ClientID that caused the exception.* **Cause** Client is unable to set Client ID on the broker and receives a `BAD_REQUEST` status from broker.
C4088	**Message** A JMS destination limit was reached. Too many producers for {0} : {1} *{0} is replaced with* `Queue` *or* `Topic` *{1} is replaced with the destination name for which the limit was reached.* **Cause** The client runtime was not able to create a message producer for the specified domain and destination due to limited broker resources.
C4089	**Message** Caught JVM Error: {0} *{0} is replaced with root cause error message.* **Cause** The client runtime caught an error thrown from the JVM; for example, `OutOfMemory` error.
C4090	**Message** Invalid port number. Broker is not available or may be paused:{0} *{0} is replaced with "[host, port]" information.* **Cause** The client runtime received an invalid port number (0) from the broker. Broker service for the request was not available or was paused.
C4091	**Message** Cannot call `Session.recover()` from a `NO_ACKNOWLEDGE` session. **Cause** The application attempts to call `Session.recover()` from a `NO_ACKNOWLEDGE` session.
C4092	**Message** Broker does not support `Session.NO_ACKNOWLEDGE` mode, broker version: {0} *{0} is replaced with the version number of the broker to which the Message Queue application is connected.* **Cause** The application attempts to create a `NO_ACKNOWLEDGE` session to a broker with version # less than 3.6.
C4093	**Message** Received wrong packet type. Expected: {0}, but received: {1} *{0} is replaced with the packet type that the Message Queue client runtime expected to receive from the broker. {1} is replaced with the packet type that the Message Queue client runtime actually received from the broker.* **Cause** The Message Queue client runtime received an unexpected Message Queue packet from broker.
C4094	**Message** The destination this message was sent to could not be found: {0} *{0} is replaced with the destination name that caused the exception.* **Cause**: A destination to which a message was sent could not be found.

Table A–2 (Cont.) Message Queue Client Error Codes

Code	Message and Description
C4095	**Message**: Message exceeds the single message size limit for the broker or destination: {0} *{0} is replaced with the destination name that caused the exception.* **Cause**: A message exceeds the single message size limit for the broker or destination.
C4096	**Message**: Destination is full and is rejecting new messages: {0} *{0} is replaced with the destination name that caused the exception.* **Cause**: A destination is full and is rejecting new messages.