# Introducing the Java Message Service

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# Section 1. Tutorial tips

## Should I take this tutorial?

This tutorial provides an overview of the Java Message Service (JMS) and offers the basics for developing programs that use it. JMS was developed by Sun Microsystems to provide a way for Java programs to access an enterprise messaging system, also known as *message oriented middleware* (MOM). MOM provides a mechanism for integrating applications in a loosely coupled, flexible manner by providing asynchronous delivery of data between applications in an indirect way through an intermediary.

Before taking this tutorial you should be familiar with Java programming and object-oriented programming concepts.

To write the programs described in this tutorial, you need an editing environment. This can be as basic as an operating system editor. In a development context, many people use an integrated development environment (IDE) because it possesses debuggers and other features designed specifically for writing and testing code.

To compile the programs, you'll need the Java compiler (javac.exe). You will also need the JMS classes in the package `javax.jms` and the Java Naming and Directory Interface (JNDI) classes in the package `javax.naming`. You can download these from Sun: *JMS* and *JNDI* .

To execute and test the programs, you will need access to a vendor implementation of JMS. Most Java 2 Enterprise Edition (J2EE) vendors provide an implementation of JMS. See your vendor documentation for setting up the JMS runtime and executing programs.

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## Getting help

For technical questions about the content of this tutorial, contact the author, Willy Farrell, at *willyf@us.ibm.com* .

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# Section 2. Introduction

## Enterprise messaging systems

The Java Message Service was developed by Sun Microsystems to provide a means for Java programs to access *enterprise messaging systems.* Before we discuss JMS, let's take a look at enterprise messaging systems.

Enterprise messaging systems, often known as *message oriented middleware* (MOM), provide a mechanism for integrating applications in a loosely coupled, flexible manner. They provide asynchronous delivery of data between applications on a *store and forward* basis; that is, the applications do not communicate directly with each other, but instead communicate with the MOM, which acts as an intermediary.

The MOM provides assured delivery of messages (or at least makes its best effort) and relieves application programmers from knowing the details of remote procedure calls (RPC) and networking/communications protocols.

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## Messaging flexibility

As shown in the figure below, Application A communicates with Application B by sending a message through the MOM's application programming interface (API).


The MOM routes the message to Application B, which may exist on a completely different computer; the MOM handles the network communications. If the network connection is not available, the MOM will store the message until the connection becomes available, and then forward it to Application B.

Another aspect of flexibility is that Application B may not even be executing when Application A sends its message. The MOM will hold the message until Application B begins execution and attempts to retrieve its messages. This also prevents Application A from blocking while it waits for Application B to receive the message.

This asynchronous communication requires applications to be designed somewhat differently than most are designed today, but it can be an extremely useful method for time-independent or parallel processing.

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## Loose coupling

The real power of enterprise messaging systems lies in the *loose coupling* of the

applications. In the diagram on the previous panel, Application A sends its messages indicating a particular destination, for example "order processing." Today, Application B provides order processing capabilities.

But, in the future, we can replace Application B with a different order-processing program, and Application A will be none the wiser. It will continue to send its messages to "order processing" and the messages will continue to be processed.

Likewise, we could replace Application A, and as long as the replacement continued to send messages for "order processing," the order-processing program would not need to know there is a new application sending orders.

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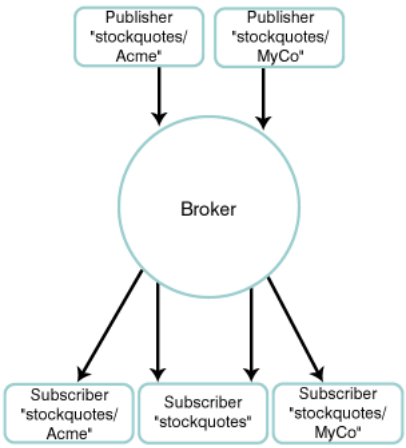
# Publish and subscribe

Originally, enterprise messaging systems were developed to implement a *point-to-point model* (PTP) in which each message produced by an application is received by one other application. In recent years, a new model has emerged, called *publish and subscribe* (or pub/sub).

Pub/sub replaces the single destination in the PTP model with a content hierarchy, known as *topics*. Sending applications *publish* their messages, indicating that the message represents information about a topic in the hierarchy.

Applications wishing to receive those messages *subscribe* to that topic. Subscribing to a topic in the hierarchy which contains subtopics allows the subscriber to receive all messages published to the topic and its subtopics.

This figure illustrates the publish and subscribe model.




Multiple applications may both subscribe and publish messages to a topic, and the applications remain anonymous to each other. The MOM acts as a *broker*, routing the published messages for a topic to all subscribers for that topic.

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# What is JMS?

The *Java Message Service specification 1.0.2* states that:

*JMS is a set of interfaces and associated semantics that define how a JMS client accesses the facilities of an enterprise messaging product.*

Prior to JMS, each MOM vendor provided application access to their product through a proprietary API, often available in multiple languages, including the Java language. JMS provides a standard, portable way for Java programs to send and receive messages through a MOM product. Programs written with JMS will be able to run on any MOM that implements the JMS standard.

The key to JMS portability is the fact that the JMS API is provided by Sun as a set of interfaces. Products that want to provide JMS functionality do so by supplying a *provider* that implements these interfaces.

As a developer, you build a JMS application by defining a set of messages and a set of client applications that exchange those messages.

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## JMS objectives

To better understand JMS, it helps to know the objectives set by the authors of the JMS specification.

There are many enterprise messaging products on the market today, and several of the *companies that produce* these products were involved in the development of JMS.

These existing systems vary in capability and functionality. The authors knew that JMS would be too complicated and unwieldy if it incorporated all of the features of all existing systems. Likewise, they believed that they could not limit themselves to only the features that all of the systems had in common.

The authors believed that it was important that JMS include all of the functionality required to implement "sophisticated enterprise applications."

The objectives of JMS, as stated in the specification, are to:

* Define a common set of messaging concepts and facilities.
* Minimize the concepts a programmer must learn to use enterprise messaging.
* Maximize the portability of messaging applications.
* Minimize the work needed to implement a provider.
* Provide client interfaces for both point-to-point and pub/sub *domains*. "Domains" is the JMS term for the messaging models discussed earlier. (Note: A provider need not implement both domains.)

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## What JMS does not provide

The following features, common in MOM products, are not addressed by the JMS specification. While acknowledged by the JMS authors as important for the development of robust messaging applications, these features are considered JMS provider-specific.

JMS providers are free to implement these features in any manner they please, if at all:

* Load balancing and fault tolerance
* Error and advisory system messages and notification
* Administration
* Security
* Wire protocol
* Message type repository

# Section 3. JMS overview and architecture

## Applications

A JMS application is comprised of the following elements:

* **JMS clients.** Java programs that send and receive messages using the JMS API.
* **Non-JMS clients.** It is important to realize that legacy programs will often be part of an overall JMS application and their inclusion must be anticipated in planning.
* **Messages.** The format and content of messages to be exchanged by JMS and non-JMS clients is integral to the design of a JMS application.
* **JMS provider.** As was stated previously, JMS defines a set of interfaces for which a provider must supply concrete implementations specific to its MOM product.
* **Administered objects.** An administrator of a messaging system provider creates objects that are isolated from the proprietary technologies of the provider.

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## Administered objects

Providers of MOM products differ significantly in the mechanisms and techniques they use to implement messaging. To keep JMS clients portable, objects that implement the JMS interfaces have to be isolated from the proprietary technologies of a provider.

The mechanism for doing this is *administered objects*. These objects, which implement JMS interfaces, are created by an administrator of the provider's messaging system and are placed in the JNDI namespace.

The objects are then retrieved by JMS programs and accessed through the JMS interfaces that they implement. The JMS provider must supply a tool that allows creation of administered objects and their placement in the JNDI namespace.

There are two types of administered objects:

* `ConnectionFactory`: Used to create a connection to the provider's underlying messaging system.
* `Destination`: Used by the JMS client to specify the destination of messages being sent or the source of messages being received.

While the administered objects themselves are instances of classes specific to a provider's implementation, they are retrieved using a portable mechanism (JNDI) and accessed through portable interfaces (JMS). The JMS program only needs to know the JNDI name and the JMS interface type of the administered object; no provider-specific knowledge is required.

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## Interfaces

JMS defines a set of high-level interfaces that encapsulate various messaging concepts. In turn, these interfaces are further defined and customized for the two messaging domains -- PTP and pub/sub.

The high-level interfaces are:

* `ConnectionFactory`: An administered object that creates a `Connection`.
* `Connection`: An active connection to a provider.
* `Destination`: An administered object that encapsulates the identity of a message destination, such as where messages are sent to or received from.
* `Session`: A single-threaded context for sending and receiving messages. For reasons of simplicity and because `Sessions` control transactions, concurrent access by multiple threads is restricted. Multiple `Sessions` can be used for multithreaded applications.
* `MessageProducer`: Used for sending messages.
* `MessageConsumer`: Used for receiving messages.

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## Interfaces (continued)

The following table identifies the domain-specific interfaces inherited from each high-level interface.

| High-level interface | PTP domain | Pub/sub domain |
|---|---|---|
| `ConnectionFactory` | `QueueConnectionFactory` | `TopicConnectionFactory` |
| `Connection` | `QueueConnection` | `TopicConnection` |
| `Destination` | `Queue` | `Topic` |
| `Session` | `QueueSession` | `TopicSession` |
| `MessageProducer` | `QueueSender` | `TopicPublisher` |
| `MessageConsumer` | `QueueReceiver`, `QueueBrowser` | `TopicSubscriber` |

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## Developing a JMS program

A typical JMS program goes through the following steps to begin producing and consuming messages.

1. Look up a `ConnectionFactory` through JNDI.
2. Look up one or more `Destinations` through JNDI.
3. Use the `ConnectionFactory` to create a `Connection`.
4. Use the `Connection` to create one or more `Sessions`.
5. Use a `Session` and a `Destination` to create the required `MessageProducers` and `MessageConsumers`.
6. Start the `Connection`.

At this point, messages can begin to flow and the application can receive, process, and send messages, as required. In later sections, we'll develop JMS programs and you'll get to see this setup in detail.

---

## Messages

At the heart of a messaging system are, of course, messages. JMS provides several message types for different types of content, but all messages derive from the `Message`

interface.

A `Message` is divided into three constituent parts:

* The **header** is a standard set of fields that are used by both clients and providers to identify and route messages.
* **Properties** provide a facility for adding optional header fields to a message. If your application needs to categorize or classify a message in a way not provided by the standard header fields, you can add a property to the message to accomplish that categorization or classification. `set<Type>Property(...)` and `Property(...)` methods are provided to set and get properties of a variety of Java types, including `Object`. JMS defines a standard set of properties that are optional for providers to supply.
* The **body** of the message contains the content to be delivered to a receiving application. Each message interface is specialized for the type of content it supports.

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# Header fields

The following list gives the name of each header field of `Message`, its corresponding Java type, and a description of the field.

* `JMSMessageID` -- type `string`
  Uniquely identifies each message that is sent by a provider. This field is set by the provider during the send process; clients cannot determine the `JMSMessageID` for a message until after it has been sent.

* `JMSDestination` -- type `Destination`
  The `Destination` to which the message was sent; set by the provider during the send process.

* `JMSDeliveryMode` -- type `int`
  Contains the value `DeliveryMode.PERSISTENT` or `DeliveryMode.NON_PERSISTENT`. A persistent message is delivered "once and only once"; a non-persistent message is delivered "at most once." Be aware that "at most once" includes not being delivered at all. A non-persistent message may be lost by a provider during application or system failure. Extra care will be taken to assure that a persistent message is not affected by failures. There is often considerable overhead in sending persistent messages, and the trade-offs between reliability and performance must be carefully considered when deciding the delivery mode of a message.

* `JMSTimestamp` -- type `long`
  The time that the message was delivered to a provider to be sent; set by the provider during the send process.

* `JMSExpiration` -- type `long`
  The time when a message should expire. This value is calculated during the send process as the sum of the time-to-live value of the sending method and the current time. Expired messages should not be delivered by the provider. A value of 0 indicates that the message will not expire.

* `JMSPriority` -- type `int`

The priority of the message; set by the provider during the send process. A priority of 0 is the lowest priority; a priority of 9 is the highest priority.

* `JMSCorrelationID` -- type `string`
  Typically used to link a response message with a request message; set by the JMS program sending the message. A JMS program responding to a message from another JMS program would copy the `JMSMessageID` of the message it is responding to into this field, so that the requesting program could *correlate* the response to the particular request that it made.

* `JMSReplyTo` -- type `Destination`
  Used by a requesting program to indicate where a reply message should be sent; set by the JMS program sending the message.

* `JMSType` -- type `string`
  Can be used by a JMS program to indicate the type of the message. Some providers maintain a repository of message types and will use this field to reference the type definition in the repository; in this case, the JMS program should not use this field.

* `JMSRedelivered` -- type `boolean`
  Indicates that the message was delivered earlier to the JMS program, but that the program did not acknowledge its receipt; set by the provider during receive processing.

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# Standard properties

The following list gives the name of each standard property of `Message`, its corresponding Java type, and a description of the property. Support for standard properties by a provider is optional. JMS reserves the "JMSX" property name for these and future JMS-defined properties.

* `JMSXUserID` -- type `string`
  Identity of the user sending the message.

* `JMSXApplID` -- type `string`
  Identity of the application sending the message.

* `JMSXDeliveryCount` -- type `int`
  Number of times delivery of the message has been attempted.

* `JMSXGroupID` -- type `string`
  Identity of the message group to which this message belongs.

* `JMSXGroupSeq` -- type `int`
  Sequence number of this message within the message group.

* `JMSXProducerTXID` -- type `string`
  Identity of the transaction within which this message was produced.

* `JMSXConsumerTXID` -- type `string`

Identity of the transaction within which this message was consumed.

* `JMSXRcvTimestamp` -- type `long`
  The time JMS delivered the message to the consumer.

* `JMSXState` -- type `int`
  Used by providers that maintain a message warehouse of messages; generally not of interest to JMS producers or consumers.

* `JMSX_<vendor_name>`
  Reserved for provider-specific properties.

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# Message body

There are five forms of message body, and each form is defined by an interface that extends `Message`. These interfaces are:

* `StreamMessage`: Contains a stream of Java primitive values that are filled and read sequentially using standard stream operations.
* `MapMessage`: Contains a set of name-value pairs; the names are of type `string` and the values are Java primitives.
* `TextMessage`: Contains a `String`.
* `ObjectMessage`: Contains a `Serializable` Java object; JDK 1.2 collection classes can be used.
* `BytesMessage`: Contains a stream of uninterpreted bytes; allows encoding a body to match an existing message format.

Each provider supplies classes specific to its product that implement these interfaces. It is important to note that the JMS specification mandates that providers must be prepared to accept and handle a `Message` object that is not an instance of one of its own `Message` classes.

While these "alien" objects may not be handled by a provider as efficiently as one of the provider's own implementations, they must be handled to ensure interoperability of all JMS providers.

---

# Transactions

A JMS transaction groups a set of produced messages and a set of consumed messages into an atomic unit of work. If an error occurs during a transaction, the production and consumption of messages that occurred before the error can be "undone."

`Session` objects control transactions and a `Session` may be denoted as *transacted* when it is created. A transacted `Session` always has a current transaction, that is, there is no `begin()`; `commit()` and `rollback()` end one transaction and automatically begin another.

Distributed transactions may be supported by the Java Transaction API (JTA) `XAResource`

API, though this is optional for providers.

---

## Acknowledgement

Acknowledgement is the mechanism whereby a provider is informed that a message has been successfully received.

If the `Session` receiving the message is transacted, acknowledgement is handled automatically. If the `Session` is not transacted, then the type of acknowledgement is determined when the `Session` is created.

There are three types of acknowledgement:

* `Session.DUPS_OK_ACKNOWLEDGE`: Lazy acknowledgement of message delivery; reduces overhead by minimizing work done to prevent duplicates; should only be used if duplicate messages are expected and can be handled.
* `Session.AUTO_ACKNOWLEDGE`: Message delivery is automatically acknowledged upon completion of the method that receives the message.
* `Session.CLIENT_ACKNOWLEDGE`: Message delivery is explicitly acknowledged by calling the `acknowledge()` method on the `Message`.

---

## Message selection

JMS provides a mechanism, called a *message selector*, for a JMS program to filter and categorize the messages it receives.

The message selector is a `String` that contains an expression whose syntax is based on a subset of SQL92. The message selector is evaluated when an attempt is made to receive a message, and only messages that match the selection criteria of the selector are made available to the program.

Selection is based on matches to header fields and properties; body values cannot be used for selection. The syntax for message selectors is provided in detail in the JMS specification.

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## JMS and XML

The authors of JMS included the `TextMessage` message type on the presumption that `String` messages will be used extensively.

Their reasoning is that XML will be a popular, if not the most popular, means of representing the content of messages. A portable transport mechanism (JMS) coupled with a portable data representation (XML) is proving to be a powerful tool in enterprise application integration (EAI) and other areas of data exchange.

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## JMS and J2EE

*J2EE version 1.2* requires compliant application servers to have the JMS API present, but does not mandate the presence of a JMS provider.

*J2EE version 1.3* will require application servers to supply a JMS provider.

Another important development in JMS capabilities is the *message-driven bean* of the *EJB 2.0 specification* , which will add asynchronous notification abilities to Enterprise JavaBeans containers. A message-driven bean, which will implement the `MessageListener` interface (see MessageListener on page 16), will be invoked by the EJB container on the arrival of a message at a destination designated at deployment time. The message-driven bean will contain the business logic to process the message, including, if needed, the invoking of other enterprise beans.

# Section 4. Point-to-point interfaces

## Introduction

In this section, we'll look at each of the important JMS interfaces for point-to-point programming and some of their methods.

In the next section (Point-to-point programming on page 17), we'll look at some sample code that performs point-to-point message processing.

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## QueueConnectionFactory

`QueueConnectionFactory` is an administered object that is retrieved from JNDI to create a connection to a provider. It contains a `createQueueConnection()` method which returns a `QueueConnection` object.

---

## QueueConnection

`QueueConnection` encapsulates an active connection to a provider. Some of its methods are:

* `createQueueSession(boolean, int)`: Returns a `QueueSession` object. The `boolean` parameter indicates whether the `QueueSession` is transacted or not; the `int` indicates the acknowledgement mode (see Acknowledgement on page 12 ).
* `start()` (inherited from `Connection`): Activates the delivery of messages from the provider.
* `stop()` (inherited from `Connection`): Temporarily stops delivery of messages; delivery can be restarted with `start()`.
* `close()` (inherited from `Connection`): Closes the connection to the provider and releases all resources held in its behalf.

---

## QueueSession

`QueueSession` is the single-threaded context for sending and receiving PTP messages. Some of its methods are:

* `createSender(Queue)`: Returns a `QueueSender` object to send messages to the specified `Queue`.
* `createReceiver(Queue)`: Returns a `QueueReceiver` object to receive messages from the specified `Queue`.
* `createBrowser(Queue)`: Returns a `QueueBrowser` object to browse messages on the specified `Queue`.
* `commit()` (inherited from `Session`): Commits all consumed or produced messages for the current transaction.
* `rollback()` (inherited from `Session`): Rolls back all consumed or produced messages for the current transaction.
* `create<MessageType>Message(...)` (inherited from `Session`): A variety of methods that return a `<MessageType>Message`, for example, `MapMessage`,

`TextMessage`, and so on.

---

# Queue

`Queue` encapsulates a point-to-point destination. It is an administered object that is retrieved from JNDI.

---

# QueueSender

`QueueSender` is used to send point-to-point messages. Some of its methods are:

* `send(Message)`: Sends the indicated `Message`.
* `setDeliveryMode(int)` (inherited from `MessageProducer`): Sets the delivery mode for subsequent messages sent; valid values are `DeliveryMode.PERSISTENT` and `DeliveryMode.NON_PERSISTENT`.
* `setPriority(int)` (inherited from `MessageProducer`): Sets the priority for subsequent messages sent; valid values are 0 through 9.
* `setTimeToLive(long)` (inherited from `MessageProducer`): Sets the duration before expiration, in milliseconds, of subsequent messages sent.

---

# QueueReceiver

`QueueReceiver` is used to receive point-to-point messages. Some of its methods are:

* `receive()` (inherited from `MessageConsumer`): Returns the next message that arrives; this method blocks until a message is available.
* `receive(long)` (inherited from `MessageConsumer`): Receives the next message that arrives within `long` milliseconds; this method returns `null` if no message arrives within the time limit.
* `receiveNoWait` (inherited from `MessageConsumer`): Receives the next message if one is immediately available; this method returns `null` if no message is available.
* `setMessageListener(MessageListener)` (inherited from `MessageConsumer`): Sets the `MessageListener`; the `MessageListener` object receives messages as they arrive, that is, asynchronously (see MessageListener on page 16).

---

# QueueBrowser

When using `QueueReceiver` to receive messages, the messages are removed from the queue when they are received. `QueueBrowser` is used to look at messages on a queue without removing them. The method for doing that is `getEnumeration()`, which returns a `java.util.Enumeration` that can be used to scan the messages in the queue; changes to the queue (arriving and expiring of messages) may or may not be visible.

---

# MessageListener

`MessageListener` is an interface with a single method -- `onMessage(Message)` -- that provides asynchronous receipt and processing of messages.

This interface should be implemented by a client class and an instance of that class passed to the `QueueReceiver` object with the `setMessageListener(MessageListener)` method. As a message arrives on a queue, it is passed to the object by calling the `onMessage(Message)` method.

`MessageListener` objects are used in both the PTP and pub/sub domains.

# Section 5. Point-to-point programming

## Introduction

In this section, we'll walk through two programs that do point-to-point messaging -- `QSender.java` and `QReceiver.java`.

We'll look at the code in small sections at a time and describe what each section does. You can see the complete listings in the Appendix: Code listing for QSender.java on page 27and Code listing for QReceiver.java on page 27.

---

## QSender: Prompt for JNDI names

All of the sample programs are command-line programs, using `System.in` for input and `System.out` for output.

The `QSender` class has two methods: `main(String[])` and `send()`. The `main(String[])` method merely instantiates a `QSender` and calls its `send()` method.

The first section of the `send()` method prompts for the JNDI names of the administered objects that will be used to send messages.

```
import java.io.*;
import javax.jms.*;
import javax.naming.*;

public class QSender {

    public static void main(String[] args) {

        new QSender().send();
    }

    public void send() {

        BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));

        try {
            //Prompt for JNDI names
            System.out.println("Enter QueueConnectionFactory name:");
            String factoryName = reader.readLine();
            System.out.println("Enter Queue name:");
            String queueName = reader.readLine();
            . . .
```

---

## QSender: Look up administered objects

The next section of the `send()` method looks up the administered objects in JNDI, using the names input earlier.

JNDI is accessed by instantiating an `InitialContext` object; the administered objects are retrieved by calling the `lookup(String)` method, passing in the name of the object to be retrieved. Note that the `lookup(String)` method returns `Object`, so a typecast must be performed on the returned object.

```
. . .
//Look up administered objects
InitialContext initContext = new InitialContext();
QueueConnectionFactory factory =
    (QueueConnectionFactory) initContext.lookup(factoryName);
Queue queue = (Queue) initContext.lookup(queueName);
initContext.close();
. . .
```

---

# QSender: Create JMS objects

Now, we create the JMS objects we need to send messages. Note that we don't directly instantiate these objects using `new`. All of the objects are created by calling a method on another object.

First, we use the `QueueConnectionFactory` to create a `QueueConnection`. We then use that `QueueConnection` to create a `QueueSession`.

The `QueueSession` is not transacted (`false`) and will use automatic acknowledgement `Session.AUTO_ACKNOWLEDGE`).

Finally, we create the `QueueSender` to send messages to the `Queue` we retrieved from JNDI.

```
. . .
//Create JMS objects
QueueConnection connection = factory.createQueueConnection();
QueueSession session =
    connection.createQueueSession(false, Session.AUTO_ACKNOWLEDGE);
QueueSender sender = session.createSender(queue);
. . .
```

---

# QSender: Send messages

Now we're ready to send messages. In this section, we enter a loop where we prompt for the text of a message to send. If the user types *quit*, the loop exits.

Otherwise, we build a `TextMessage` from the entered text and use the `QueueSender` to send the message, then return to the top of the loop.

```
. . .
//Send messages
String messageText = null;
while (true) {
    System.out.println("Enter message to send or 'quit':");
    messageText = reader.readLine();
    if ("quit".equals(messageText))
        break;
    TextMessage message = session.createTextMessage(messageText);
    sender.send(message);
}
. . .
```

## QSender: Exit

Once the loop exits, we close the `QueueConnection`. Closing the `QueueConnection` automatically closes the `QueueSession` and `QueueSender`.

```
            . . .
            //Exit
            System.out.println("Exiting...");
            reader.close();
            connection.close();
            System.out.println("Goodbye!");

        } catch (Exception e) {
            e.printStackTrace();
            System.exit(1);
        }
    }
}
```

## QReceiver: Prompt for JNDI names and look up administered objects

The `QReceiver` class, like the `QSender` class, has a `main(String[])` method that simply instantiates a `QReceiver` and calls its primary method, `receive()`.

The code for prompting for JNDI names and doing the lookup of administered objects is identical to that in `QSender`.

There are two differences in this class, however:

* The `boolean stop` instance variable is used to indicate that the program should exit.
* `QReceiver` implements the `MessageListener` interface in order to receive messages asynchronously.

```
import java.io.*;
import javax.jms.*;
import javax.naming.*;

public class QReceiver implements MessageListener {

    private boolean stop = false;

    public static void main(String[] args) {

        new QReceiver().receive();
    }

    public void receive() {

        BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));

        try {
            //Prompt for JNDI names
            System.out.println("Enter QueueConnectionFactory name:");
            String factoryName = reader.readLine();
            System.out.println("Enter Queue name:");
            String queueName = reader.readLine();
            reader.close();
```

```
            //Look up administered objects
            InitialContext initContext = new InitialContext();
            QueueConnectionFactory factory =
                (QueueConnectionFactory) initContext.lookup(factoryName);
            Queue queue = (Queue) initContext.lookup(queueName);
            initContext.close();
            . . .
```

## QReceiver: Create JMS objects

The `QueueConnection` and `QueueSession` are created as they are in `QSender` and then a `QueueReceiver` is created.

Next, `setMessageListener()` is called, passing in `this` -- the local instance of `QReceiver`, which you will recall implements the `MessageListener` interface.

Finally, the `QueueConnection` is started to allow messages to be received.

```
            . . .
            //Create JMS objects
            QueueConnection connection = factory.createQueueConnection();
            QueueSession session =
                connection.createQueueSession(false, Session.AUTO_ACKNOWLEDGE);
            QueueReceiver receiver = session.createReceiver(queue);
            receiver.setMessageListener(this);
            connection.start();
            . . .
```

## QReceiver: Wait for stop and exit

Next, the program goes into a loop that will exit when the `stop` variable becomes true. In the loop, the thread sleeps for one second. Once the loop has exited, the `QueueConnection` is closed and the program terminates.

```
            . . .
            //Wait for stop
            while (!stop) {
                Thread.sleep(1000);
            }

            //Exit
            System.out.println("Exiting...");
            connection.close();
            System.out.println("Goodbye!");

        } catch (Exception e) {
            e.printStackTrace();
            System.exit(1);
        }
    }
    . . .
```

# QReceiver: onMessage(Message) method

This is the `onMessage(Message)` method of the `QReceiver` class. The presence of this method is required because `QReceiver` implements the `MessageListener` interface.

When a message is received, this method is called with the `Message` passed as the parameter.

In our implementation, we get the text content of the message and print it to `System.out`. We then check to see if the message equals *stop*, and if it does, the `stop` variable is set to `true`; this allows the loop in the `receive()` method to terminate.

```
    . . .
    public void onMessage(Message message) {

        try {
            String msgText = ((TextMessage) message).getText();
            System.out.println(msgText);
            if ("stop".equals(msgText))
                stop = true;
        } catch (JMSException e) {
            e.printStackTrace();
            stop = true;
        }
    }
}
```

---

# Running the programs

As indicated in the Tutorial tips on page 2 , you will need the `javax.naming` and `javax.jms` packages to compile these programs.

Before you run these programs, you'll need to use the administration tool supplied by your JMS provider to create the `QueueConnectionFactory` and `Queue` administered objects and place them in the JNDI namespace.

You also need to make sure that the provider's JMS implementation classes are on your classpath.

You can then run both of these programs at the same time, supplying the same JNDI names for the `QueueConnectionFactory` and `Queue`, and send messages from the `QSender` to the `QReceiver`.

# Section 6. Pub/sub interfaces

## Introduction

Now let's look at the pub/sub interfaces. As we go through them, notice how they are very much like the PTP interfaces, except for the names and a few other differences.

---

## TopicConnectionFactory

`TopicConnectionFactory` is an administered object that is retrieved from JNDI in order to create a connection to a provider. It contains a `createTopicConnection()` method which returns a `TopicConnection` object.

---

## TopicConnection

`TopicConnection` encapsulates an active connection to a provider. Some of its methods are:

* `createTopicSession(boolean, int)`: Returns a `TopicSession` object. The `boolean` parameter indicates whether the `TopicSession` is transacted; the `int` indicates the acknowledgement mode (see Acknowledgement on page 12 ).
* `start()` (inherited from `Connection`): Activates the delivery of messages from the provider.
* `stop()` (inherited from `Connection`): Temporarily stops delivery of messages; delivery can be restarted with `start()`.
* `close()` (inherited from `Connection`): Closes the connection to the provider and releases all resources held in its behalf.

---

## TopicSession

`TopicSession` is the single-threaded context for sending and receiving pub/sub messages. Some of its methods are:

* `createPublisher(Topic)`: Returns a `TopicPublisher` object to send messages to the specified `Topic`.
* `createSubscriber(Topic)`: Returns a `TopicSubscriber` object to receive messages from the specified `Topic`. This subscriber is *non-durable* ; that is, the subscription will only last for the lifetime of the object and will only receive messages when it is active.
* `createDurableSubscriber(Topic, String)`: Returns a `TopicSubscriber` object to receive messages from the specified `Topic`, giving the `String` name to the subscriber. Messages for a *durable* subscriber will be retained by JMS if the object is not active and will be delivered to subsequent subscriber objects that are created with the same name.
* `unsubscribe(String)`: Ends the subscription with the `String` name.
* `commit()` (inherited from `Session`): Commits all consumed or produced messages for the current transaction.
* `rollback()` (inherited from `Session`): Rolls back all consumed or produced

messages for the current transaction.
* `create<MessageType>Message(...)` (inherited from `Session`): A variety of methods that return a `<MessageType>Message`, such as `MapMessage`, `TextMessage`, and so on.

---

# Topic

`Topic` encapsulates a pub/sub destination. It is an administered object that is retrieved from JNDI.

---

# TopicPublisher

`TopicPublisher` is used to send pub/sub messages. Some of its methods are:
* `publish(Message)`: Publishes the indicated `Message`.
* `setDeliveryMode(int)` (inherited from `MessageProducer`): Sets the delivery mode for subsequent messages sent; valid values are `DeliveryMode.PERSISTENT` and `DeliveryMode.NON_PERSISTENT`.
* `setPriority(int)` (inherited from `MessageProducer`): Sets the priority for subsequent messages sent; valid values are 0 through 9.
* `setTimeToLive(long)` (inherited from `MessageProducer`): Sets the duration before expiration, in milliseconds, of subsequent messages sent.

---

# TopicSubscriber

`TopicSubscriber` is used to receive point-to-point messages. Some of its methods are:
* `receive()` (inherited from `MessageConsumer`): Returns the next message that arrives; this method blocks until a message is available.
* `receive(long)` (inherited from `MessageConsumer`): Receives the next message that arrives within `long` milliseconds; this method returns `null` if no message arrives within the time limit.
* `receiveNoWait` (inherited from `MessageConsumer`): Receives the next message if one is immediately available; this method returns `null` if no message is available.
* `setMessageListener(MessageListener)` (inherited from `MessageConsumer`): Sets the `MessageListener`; the `MessageListener` object receives messages as they arrive, that is, asynchronously (see MessageListener on page 16 ).

# Section 7. Pub/sub programming

## The same, but different

Two pub/sub programs are available in the Appendix -- Code listing for TPublisher.java on page 28and Code listing for TSubscriber.java on page 29. We won't go through them step-by-step as we did the PTP programs because, other than the types of JMS interfaces used, they are identical to `QSender.java` and `QReceiver.java`.

You'll need to set up `TopicConnectionFactory` and `Topic` administered objects before you run these programs.

You'll see the difference between these and the PTP programs once you run them. If you run multiple instances of `QReceiver` using the same `QueueConnectionFactory` and `Queue`, you'll see that as you send messages from `QSender` that only one of the `QReceiver` instances receives each message sent.

If you run multiple instances of `TSubscriber`, you'll see that all messages sent from `TPublisher` are received by all instances of `TSubscriber`.

# Section 8. Summary

## Wrapup

This tutorial has provided an introduction and overview of the Java Message Service and its functionality and capabilities. It has also demonstrated basic programming techniques for creating JMS programs and provided sample code to illustrate those programs.

We did not look at every interface and class in the JMS API, nor did we look at every method on those interfaces we did examine. The Resources on page 25provides some pointers to materials to help you do that.

The goal here is to get you started with JMS and give you some basic working programs to learn from. Once you have the sample programs up and running, experiment by modifying them to use message selection, durable subscriptions, and some of the other capabilities of JMS that we touched on here but did not demonstrate in the sample programs.

---

## Resources

* *The Java Message Service specification, version 1.0.2* is the best source of information for understanding the finer details of JMS.
* The *JMS API documentation* is essential for JMS programming.
* You'll need to download the *javax.jms* package and *javax.naming* package to complete this tutorial.
* For enterprise development, you'll need the Java 2 Enterprise Edition. *J2EE version 1.2* requires compliant application servers to have the JMS API present, but does not mandate the presence of a JMS provider; *J2EE version 1.3* will require application servers to supply a JMS provider.
* Message-driven beans, part of the *EJB 2.0 specification* , add asynchronous notification abilities to Enterprise JavaBeans containers.
* developerWorks contributor Todd Sundsted discusses how JMS combines with XML to *improve enterprise application interoperability* . He also demonstrates how these two technologies work together to *route messages based on their content* .
* *"Java Message Service"* (O'Reilly and Associates, 2000), by Richard Monson-Haefel and David Chappell, is an excellent O'Reilly book on the subject.
* " *Writing Java Message Service programs using MQSeries and VisualAge for Java, Enterprise Edition* ," also by Willy Farrell, describes how to obtain, install, and use IBM tools to write JMS programs.
* Ryan Cox and Greg Wadley wrote a comprehensive two-part series on using JMS with WebSphere and Visual Age for Java. *Part 1* provides a thorough discussion of the players and also command bean that allows you to easily integrate JMS services into your own applications. *Part 2* provides a sample Web application that shows how to use the command bean to develop a publish/subscribe scenario running under WebSphere Application Server.

---

# Your feedback

Please let us know whether this tutorial was helpful to you and how we could make it better. We'd also like to hear about other tutorial topics you'd like to see covered. Thanks!

For questions about the content of this tutorial, contact the author, Willy Farrell, at *willyf@us.ibm.com* .

# Section 9. Appendix

## Code listing for QSender.java

```
import java.io.*;
import javax.jms.*;
import javax.naming.*;

public class QSender {

    public static void main(String[] args) {

        new QSender().send();
    }

    public void send() {

        BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));

        try {
            //Prompt for JNDI names
            System.out.println("Enter QueueConnectionFactory name:");
            String factoryName = reader.readLine();
            System.out.println("Enter Queue name:");
            String queueName = reader.readLine();

            //Look up administered objects
            InitialContext initContext = new InitialContext();
            QueueConnectionFactory factory =
                (QueueConnectionFactory) initContext.lookup(factoryName);
            Queue queue = (Queue) initContext.lookup(queueName);
            initContext.close();

            //Create JMS objects
            QueueConnection connection = factory.createQueueConnection();
            QueueSession session =
                connection.createQueueSession(false, Session.AUTO_ACKNOWLEDGE);
            QueueSender sender = session.createSender(queue);

            //Send messages
            String messageText = null;
            while (true) {
                System.out.println("Enter message to send or 'quit':");
                messageText = reader.readLine();
                if ("quit".equals(messageText))
                    break;
                TextMessage message = session.createTextMessage(messageText);
                sender.send(message);
            }

            //Exit
            System.out.println("Exiting...");
            reader.close();
            connection.close();
            System.out.println("Goodbye!");

        } catch (Exception e) {
            e.printStackTrace();
            System.exit(1);
        }
    }
}
```

---

## Code listing for QReceiver.java

```
import java.io.*;
import javax.jms.*;
```

```
import javax.naming.*;

public class QReceiver implements MessageListener {

    private boolean stop = false;

    public static void main(String[] args) {

        new QReceiver().receive();
    }

    public void receive() {

        BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));

        try {
            //Prompt for JNDI names
            System.out.println("Enter QueueConnectionFactory name:");
            String factoryName = reader.readLine();
            System.out.println("Enter Queue name:");
            String queueName = reader.readLine();
            reader.close();

            //Look up administered objects
            InitialContext initContext = new InitialContext();
            QueueConnectionFactory factory =
                (QueueConnectionFactory) initContext.lookup(factoryName);
            Queue queue = (Queue) initContext.lookup(queueName);
            initContext.close();

            //Create JMS objects
            QueueConnection connection = factory.createQueueConnection();
            QueueSession session =
                connection.createQueueSession(false, Session.AUTO_ACKNOWLEDGE);
            QueueReceiver receiver = session.createReceiver(queue);
            receiver.setMessageListener(this);
            connection.start();

            //Wait for stop
            while (!stop) {
                Thread.sleep(1000);
            }

            //Exit
            System.out.println("Exiting...");
            connection.close();
            System.out.println("Goodbye!");

        } catch (Exception e) {
            e.printStackTrace();
            System.exit(1);
        }
    }

    public void onMessage(Message message) {

        try {
            String msgText = ((TextMessage) message).getText();
            System.out.println(msgText);
            if ("stop".equals(msgText))
                stop = true;
        } catch (JMSException e) {
            e.printStackTrace();
            stop = true;
        }
    }
}
```

---

# Code listing for TPublisher.java

```
import java.io.*;
import javax.jms.*;
import javax.naming.*;

public class TPublisher {

    public static void main(String[] args) {

        new TPublisher().publish();
    }

    public void publish() {

        BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));

        try {
            //Prompt for JNDI names
            System.out.println("Enter TopicConnectionFactory name:");
            String factoryName = reader.readLine();
            System.out.println("Enter Topic name:");
            String topicName = reader.readLine();

            //Look up administered objects
            InitialContext initContext = new InitialContext();
            TopicConnectionFactory factory =
                (TopicConnectionFactory) initContext.lookup(factoryName);
            Topic topic = (Topic) initContext.lookup(topicName);
            initContext.close();

            //Create JMS objects
            TopicConnection connection = factory.createTopicConnection();
            TopicSession session =
                connection.createTopicSession(false, Session.AUTO_ACKNOWLEDGE);
            TopicPublisher publisher = session.createPublisher(topic);

            //Send messages
            String messageText = null;
            while (true) {
                System.out.println("Enter message to send or 'quit':");
                messageText = reader.readLine();
                if ("quit".equals(messageText))
                    break;
                TextMessage message = session.createTextMessage(messageText);
                publisher.publish(message);
            }

            //Exit
            System.out.println("Exiting...");
            reader.close();
            connection.close();
            System.out.println("Goodbye!");

        } catch (Exception e) {
            e.printStackTrace();
            System.exit(1);
        }
    }
}
```

---

# Code listing for TSubscriber.java

```
import java.io.*;
import javax.jms.*;
import javax.naming.*;

public class TSubscriber implements MessageListener {

    private boolean stop = false;
```

```
    public static void main(String[] args) {

        new TSubscriber().subscribe();
    }

    public void subscribe() {

        BufferedReader reader = new BufferedReader(new InputStreamReader(System.in));

        try {
            //Prompt for JNDI names
            System.out.println("Enter TopicConnectionFactory name:");
            String factoryName = reader.readLine();
            System.out.println("Enter Topic name:");
            String topicName = reader.readLine();
            reader.close();

            //Look up administered objects
            InitialContext initContext = new InitialContext();
            TopicConnectionFactory factory =
                (TopicConnectionFactory) initContext.lookup(factoryName);
            Topic topic = (Topic) initContext.lookup(topicName);
            initContext.close();

            //Create JMS objects
            TopicConnection connection = factory.createTopicConnection();
            TopicSession session =
                connection.createTopicSession(false, Session.AUTO_ACKNOWLEDGE);
            TopicSubscriber subscriber = session.createSubscriber(topic);
            subscriber.setMessageListener(this);
            connection.start();

            //Wait for stop
            while (!stop) {
                Thread.sleep(1000);
            }

            //Exit
            System.out.println("Exiting...");
            connection.close();
            System.out.println("Goodbye!");

        } catch (Exception e) {
            e.printStackTrace();
            System.exit(1);
        }
    }

    public void onMessage(Message message) {

        try {
            String msgText = ((TextMessage) message).getText();
            System.out.println(msgText);
            if ("stop".equals(msgText))
                stop = true;
        } catch (JMSException e) {
            e.printStackTrace();
            stop = true;
        }
    }
}
```

## Colophon

This tutorial was written entirely in XML, using the developerWorks Toot-O-Matic tutorial generator. The Toot-O-Matic tool is a short Java program that uses XSLT stylesheets to

convert the XML source into a number of HTML pages, a zip file, JPEG heading graphics, and PDF files. Our ability to generate multiple text and binary formats from a single source file illustrates the power and flexibility of XML.