Java Message Service

The JMS API is an API for accessing enterprise messaging systems from Java programs

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# Introduction

## Abstract

This specification describes the objectives and functionality of the JavaTM Message Service (JMS).

JMS provides a common way for Java programs to create, send, receive and read an enterprise messaging system’s messages.

## Overview

Enterprise messaging products (or as they are sometimes called, Message Oriented Middleware products) are becoming an essential component for integrating intra-company operations. They allow separate business components to be combined into a reliable, yet flexible, system.

In addition to the traditional MOM vendors, enterprise messaging products are also provided by several database vendors and a number of internet related companies.

Java language clients and Java language middle tier services must be capable of using these messaging systems. JMS provides a common way for Java language programs to access these systems.

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

Since messaging is peer-to-peer, all users of JMS are referred to generically as clients. A JMS application is made up of a set of application defined messages and a set of clients that exchange them.

Products that implement JMS do this by supplying a provider that implements the JMS interfaces.

### Is this a mail API?

The term messaging is quite broadly defined in computing. It is used for describing various operating system concepts; it is used to describe email and fax systems; and here, it is used to describe asynchronous communication between enterprise applications.

Messages, as described here, are asynchronous requests, reports or events that are consumed by enterprise applications, not humans. They contain vital information needed to coordinate these systems. They contain precisely formatted data that describe specific business actions. Through the exchange of these messages each application tracks the progress of the enterprise.

### Existing messaging systems

Messaging systems are peer-to-peer facilities. In general, each client can send messages to, and receive messages from any client. Each client connects to a messaging agent which provides facilities for creating, sending and receiving messages.

Each system provides a way of addressing messages. Each provides a way to create a message and fill it with data.

Some systems are capable of broadcasting a message to many destinations. Others only support sending a message to a single destination.

Some systems provide facilities for asynchronous receipt of messages (messages are delivered to a client as they arrive). Others support only synchronous receipt (a client must request each message).

Each messaging system typically provides a range of service that can be selected on a per message basis. One important attribute is the lengths to which the system will go to ensure delivery. This varies from simple best effort to guaranteed, only once delivery. Other important attributes are message time-to-live, priority and whether a response is required.

### JMS objectives

If JMS provided a union of all the existing features of messaging systems it would be much too complicated for its intended users. On the other hand, JMS is more than an intersection of the messaging features common to all products. It is crucial that JMS include the functionality needed to implement sophisticated enterprise applications.

JMS defines a common set of enterprise messaging concepts and facilities. It attempts to minimize the set of concepts a Java language programmer must learn to use enterprise messaging products. It strives to maximize the portability of messaging applications.

#### JMS provider

As noted earlier, a JMS provider is the entity which implements JMS for a messaging product.

Ideally, JMS providers will be written in 100% Pure Java so they can run in applets; simplify installation; and, work across architectures and OS’s.

An important goal of JMS is to minimize the work needed to implement a provider.

#### JMS messages

JMS defines a set of message interfaces.

Clients use the message implementations supplied by their JMS provider.

A major goal of JMS is that clients have a consistent API for creating and working with messages which is independent of JMS provider.

#### JMS domains

Messaging products can be broadly classified as either point-to-point or publish-subscribe systems.

Point-to-point (PTP) products are built around the concept of message queues. Each message is addressed to a specific queue; clients extract messages from the queue(s) established to hold their messages.

Publish and subscribe (Pub/Sub) clients address messages to some node in a content hierarchy. Publishers and subscribers are generally anonymous and may dynamically publish or subscribe to the content hierarchy. The system takes care of distributing the messages arriving from a node’s multiple publishers to its multiple subscribers.

JMS provides a set of interfaces that allow the client to send and receive messages in both domains, while supporting the semantics of each domain. JMS also provides client interfaces tailored for each domain. Prior to version 1.1 of the JMS specification, only the client interfaces that were tailored to each domain were available. These interfaces continue to be supported to provide backward compatibility for those who have already implemented JMS clients using them. The preferred approach for implementing clients is to use the domain-independent interfaces. These interfaces, referred to as the “common interfaces”, are parents of the domain-specific interfaces.

#### Portability

The primary portability objective is that new, JMS only, applications are portable across products within the same messaging domain.

This is in addition to the expected portability of a JMS client across machine architectures and operating systems (when using the same JMS provider).

Although JMS is designed to allow clients to work with existing message formats used in a mixed language application, portability of such clients is not generally achievable (porting a mixed language application from one product to another is beyond the scope of JMS).

### What JMS does not include

JMS does not address the following functionality:

* Load Balancing/Fault Tolerance - Many products provide support for multiple, cooperating clients implementing a critical service. The JMS API does not specify how such clients cooperate to appear to be a single, unified service.
* Error/Advisory Notification - Most messaging products define system messages that provide asynchronous notification of problems or system events to clients. JMS does not attempt to standardize these messages. By following the guidelines defined by JMS, clients can avoid using these messages and thus prevent the portability problems their use introduces.
* Administration - JMS does not define an API for administering messaging products.
* Security - JMS does not specify an API for controlling the privacy and integrity of messages. It also does not specify how digital signatures or keys are distributed to clients. Security is considered to be a JMS provider-specific feature that is configured by an administrator rather than controlled via the JMS API by clients.
* Wire Protocol - JMS does not define a wire protocol for messaging.
* Message Type Repository - JMS does not define a repository for storing message type definitions and it does not define a language for creating message type definitions.

## What is required by JMS

The functionality discussed in the specification is required of all JMS providers unless it is explicitly noted otherwise.

JMS is also used within the Java Platform, Enterprise Edition (Java EE). See section 1.4 "Relationship to other Java APIs" for additional requirements for JMS when it is integrated into a Java EE environment.

## Relationship to other Java APIs

### Java DataBase Connectivity (JDBCTM) software

JMS clients may also use the JDBC API. They may desire to include the use of both the JDBC API and the JMS API in the same transaction. In most cases, this will be achieved automatically by implementing these clients as Enterprise JavaBeansTM components. It is also possible to do this directly with the Java Transaction API (JTA).

### JavaBeansTM components

JavaBeans components can use a JMS session to send/receive messages. JMS itself is an API and the interfaces it defines are not designed to be used directly as JavaBeans components.

### Enterprise JavaBeansTM component model

The JMS API is an important resource available to Enterprise Java Beans (EJBTM) component developers. It can be used in conjunction with other resources like JDBC to implement enterprise services.

The EJB specification defines beans that are invoked synchronously via method calls from EJB clients. It also defines a form of asynchronous bean that is invoked when a JMS client sends it a message, called a message-driven bean. The EJB specification supports both synchronous and asynchronous message consumption. In addition, EJB specifies how the JMS API participates in bean-managed or container-managed transactions. The EJB specification restricts how to use JMS interfaces when implementing EJB clients. Refer to the EJB specification for the details.

### Java Transaction API (JTA)

The javax.transaction package provides a client API for delimiting distributed transactions and an API for accessing a resource’s ability to participate in a distributed transaction.

A JMS client may use JTA to delimit distributed transactions; however, this is a function of the transaction environment the client is running in. It is not a feature of JMS.

A JMS provider can optionally support distributed transactions via JTA.

The JTA specification also defines a scope @TransactionScope which is referred to in section 11.3.4 "Scope of injected JMSContext objects".

### Java Transaction Service (JTS)

JMS can be used in conjunction with JTS to form distributed transactions that combine message sends and receives with database updates and other JTS aware services. This should be handled automatically when a JMS client is run from within an application server such as an Enterprise JavaBeans server; however, it is also possible for JMS clients to program this explicitly.

### Java Naming and Directory InterfaceTM (JNDI) API

JMS clients look up configured JMS objects using the JNDI API. JMS administrators use provider-specific facilities for creating and configuring these objects.

This division of work maximizes the portability of clients by delegating provider specific work to the administrator. It also leads to more administrable applications because clients do not need to embed administrative values in their code.

### Java Platform, Enterprise Edition (Java EE)

The Java™ Platform, Enterprise Edition (Java EE) Specification, v7 requires support for the JMS API as part of the Java EE platform. The Java EE platform specification places certain additional requirements on the implementation and use of the JMS API. The most important requirements are described in chapter 10 "Use of JMS API in Java EE applications".

### Contexts and dependency injection (CDI)

This specification defines how JMSContext objects may be injected into Java EE web or EJB applications. See section 11.3 "Injection of JMSContext objects" for more information. The CDI (Contexts and dependency injection) specification defines the concepts and technology on which this is based.

## What is new in JMS 1.1?

In previous versions of JMS, client programming for the Point-to-Point and Pub/Sub domains was done using similar but separate class hierarchies. In JMS 1.1, there is now a domain-independent approach to programming the client application. This provides several benefits:

* For the client programmer, a simpler programming model
* The ability to engage queues and topics in the same transaction, now that they can be created in the same session
* For the JMS provider, increased opportunity to optimize implementations by pooling thread management
* To take advantage of these features, the developer of JMS clients needs to use the domain-independent or “common” APIs. In the future, some of the domain-specific APIs may be deprecated.

In JMS 1.1, all of the classes and methods from JMS 1.0.2b are retained to provide backward compatibility. The semantics of the two messaging domains are retained; the expected behavior of a Point-to-Point domain and a Pub/Sub domain remain the same, as described in chapter 5 "JMS point-to-point model" and chapter 6 "JMS publish/subscribe model"

To see details of the changes made to this specification, see chapter B "Change history".

## What is new in JMS 2.0?

A full list of the new features, changes and clarifications introduced in JMS 2.0 is given in section B.5 "Version 2.0" of the "Change history" chapter. Here is a summary:

The JMS 2.0 specification now requires JMS providers to implement both P2P and Pub-Sub.

The following new messaging features have been added in JMS 2.0:

* Delivery delay: a message producer can now specify that a message must not be delivered until after a specified time interval.
* New send methods have been added to allow an application to send messages asynchronously.
* JMS providers must now set the JMSXDeliveryCount message property.

Several changes have been made to the JMS API to make it simpler and easier to use:

* Connection, Session and other objects with a close() method now implement the java.jang.AutoCloseable interface to allow them to be used in a Java SE 7 try-with-resources statement.
* A new "simplified API" has been added which offers a simpler alternative to the standard API, especially in Java EE applications.
* New methods have been added to create a session without the need to supply redundant arguments.
* Client ID is now optional when creating a durable subscription

The following change has been made to aid scalability:

* Applications are now permitted to create multiple consumers on the same durable or non-durable topic subscription. In previous versions of JMS only a single consumer was permitted.

A new chapter has been added which describes some additional restrictions and behaviour which apply when using the JMS API in the Java EE web or EJB container. This information was previously only available in the EJB and Java EE platform specifications.

New methods have been added to Session which return a MessageConsumer on a durable topic subscription. Applications could previously only obtain a domain-specific TopicSubscriber, even though its use was discouraged.

The specification has been clarified in various places.

# Architecture

## Overview

This chapter describes the environment of message based applications and the role JMS plays in this environment.

## What is a JMS application?

A JMS application is composed of the following parts:

* JMS Clients - These are the Java language programs that send and receive messages.
* Non-JMS Clients - These are clients that use a message system's native client API instead of JMS. If the application predated the availability of JMS it is likely that it will include both JMS and non-JMS clients.
* Messages - Each application defines a set of messages that are used to communicate information between its clients.
* JMS Provider - This is a messaging system that implements JMS in addition to the other administrative and control functionality required of a full featured messaging product.
* Administered Objects - Administered objects are preconfigured JMS objects created by an administrator for the use of clients.

## Administration

It is expected that each JMS provider will differ significantly in its underlying messaging technology. It is also expected there will be major differences in how a provider’s system is installed and administered.

If JMS clients are to be portable, they must be isolated from these proprietary aspects of a provider. This is done by defining JMS administered objects that are created and customized by a provider’s administrator and later used by clients. The client uses them through JMS interfaces that are portable. The administrator creates them using provider-specific facilities.

There are two types of JMS administered objects:

* ConnectionFactory - This is the object a client uses to create a connection with a provider.
* Destination - This is the object a client uses to specify the destination of messages it is sending and the source of messages it receives.

Administered objects are placed in a JNDI namespace by an administrator. A JMS client typically notes in its documentation the JMS administered objects it requires and how the JNDI names of these objects should be provided to it. Figure 2.1 illustrates how JMS administration ordinarily works.

Figure 2.1 JMS Administration



## Two messaging styles

A JMS application can use either the point-to-point (PTP) and the publish-and-subscribe (pub/sub) style of messaging, which are described in more detail later in this specification. An application can also combine both styles of messaging in one application. These two styles of messaging are often referred to as messaging domains. JMS provides these two messaging domains because they represent two common models for messaging.

When using the JMS API, a developer can use interfaces and methods that support both models of messaging. When using these interfaces, the behavior of the messaging system may be somewhat different, because the two messaging domains have different semantics. These semantic differences are described in Chapter 5 "JMS point-to-point model" and Chapter 6 "JMS publish/subscribe model".

## JMS interfaces

JMS is based on a set of common messaging concepts. Each JMS messaging domain - PTP and Pub/Sub - define their customized set of interfaces for these concepts.

Table 2.1 Relationship of PTP and Pub/Sub Interfaces

|  |  |  |
| --- | --- | --- |
| JMS Common Interfaces | PTP-specific Interfaces | Pub/Sub-specific interfaces |
| ConnectionFactory | QueueConnectionFactory | TopicConnectionFactory |
| Connection | QueueConnection | TopicConnection |
| Destination | Queue | Topic |
| Session | QueueSession | TopicSession |
| MessageProducer | QueueSender | TopicPublisher |
| MessageConsumer | QueueReceiver, QueueBrowser | TopicSubscriber |

The JMS common interfaces provide a domain-independent view of the PTP and Pub/Sub messaging domains. JMS client programmers are encouraged to use these interfaces to create their client programs.

The following list provides a brief definition of these JMS concepts. See Chapter 4 "JMS common facilities" for more details about these concepts.

For the details about the differences in the two messaging domains, see Chapter 5 "JMS point-to-point model" and Chapter JMS publish/subscribe model, “JMS Publish/Subscribe Model.”

* ConnectionFactory - an administered object used by a client to create a Connection
* Connection - an active connection to a JMS provider
* Destination - an administered object that encapsulates the identity of a message destination
* Session - a single-threaded context for sending and receiving messages
* MessageProducer - an object created by a Session that is used for sending messages to a destination
* MessageConsumer - an object created by a Session that is used for receiving messages sent to a destination

Figure 2.2 Overview of JMS object relationships



The term *consume* is used in this document to mean the receipt of a message by a JMS client; that is, a JMS provider has received a message and has given it to its client. Since JMS supports both synchronous and asynchronous receipt of messages, the term *consume* is used when there is no need to make a distinction between them.

The term *produce* is used as the most general term for sending a message. It means giving a message to a JMS provider for delivery to a destination.

## Developing a JMS application

Broadly speaking, a JMS application is one or more JMS clients that exchange messages. The application may also involve non-JMS clients; however, these clients use the JMS provider’s native API in place of JMS.

A JMS application can be architected and deployed as a unit. In many cases, JMS clients are added incrementally to an existing application.

The message definitions used by an application may originate with JMS or they may have been defined by the non-JMS part of the application.

### Developing a JMS client

A typical JMS client executes the following JMS setup procedure:

* Use JNDI to find a ConnectionFactory object
* Use JNDI to find one or more Destination objects
* Use the ConnectionFactory to create a JMS Connection with message delivery inhibited
* Use the Connection to create one or more JMS Sessions
* Use a Session and the Destinations to create the MessageProducers and MessageConsumers needed

•Tell the Connection to start delivery of messages

At this point a client has the basic JMS setup needed to produce and consume messages.

## Security

JMS does not provide features for controlling or configuring message integrity or message privacy.

It is expected that many JMS providers will provide such features. It is also expected that configuration of these services will be handled by provider-specific administration tools. Clients will get the proper security configuration as part of the administered objects they use.

## Multi-threading

JMS could have required that all its objects support concurrent use. Since support for concurrent access typically adds some overhead and complexity, the JMS design restricts its requirement for concurrent access to those objects that would naturally be shared by a multi-threaded client. The remainder are designed to be accessed by one logical thread of control at a time.

Table 2.2 JMS objects that support concurrent use

|  |  |
| --- | --- |
| JMS Object | Supports Concurrent Use |
| Destination | YES |
| ConnectionFactory | YES |
| Connection | YES |
| Session | NO |
| MessageProducer | NO |
| MessageConsumer | NO |

JMS defines some specific rules that restrict the concurrent use of Sessions. Since they require more knowledge of JMS specifics than we have presented at this point, they will be described later. Here we will describe the rationale for imposing them.

There are two reasons for restricting concurrent access to Sessions. First, Sessions are the JMS entity that supports transactions. It is very difficult to implement transactions that are multi-threaded. Second, Sessions support asynchronous message consumption. It is important that JMS not require that client code used for asynchronous message consumption be capable of handling multiple, concurrent messages. In addition, if a Session has been set up with multiple, asynchronous consumers, it is important that the client is not forced to handle the case where these separate consumers are concurrently executing. These restrictions make JMS easier to use for typical clients. More sophisticated clients can get the concurrency they desire by using multiple sessions.

## Triggering clients

Some clients are designed to periodically wake up and process messages waiting for them. A message-based application triggering mechanism is often used with this style of client. The trigger is typically a threshold of waiting messages, etc.

JMS does not provide a mechanism for triggering the execution of a client. Some providers may supply such a triggering mechanism via their administrative facilities.

## Request/reply

JMS provides the JMSReplyTo message header field for specifying the Destination where a reply to a message should be sent. The JMSCorrelationID header field of the reply can be used to reference the original request. See Section 3.4 "Message header fields" for more information.

In addition, JMS provides a facility for creating temporary queues and topics that can be used as a unique destination for replies.

Enterprise messaging products support many styles of request/reply, from the simple “one message request yields a one message reply” to “one message request yields streams of messages from multiple respondents.” Rather than architect a specific JMS request/reply abstraction, JMS provides the basic facilities on which many can be built.

For convenience, JMS defines request/reply helper classes (classes written using JMS) for both the PTP and Pub/Sub domains that implement a basic form of request/reply. JMS providers and clients may provide more specialized implementations.

# JMS message model

## Background

Enterprise messaging products treat messages as lightweight entities that consist of a header and a body. The header contains fields used for message routing and identification; the body contains the application data being sent.

Within this general form, the definition of a message varies significantly across products. There are major differences in the content and semantics of headers. Some products use a self describing, canonical encoding of message data; others treat data as completely opaque. Some products provide a repository for storing message descriptions that can be used to identify and interpret message content; others don’t.

It would be quite difficult for JMS to capture the breadth of this, sometimes conflicting, union of message models.

## Goals

The JMS message model has the following goals:

* Provide a single, unified message API
* Provide an API suitable for creating messages that match the format used by existing, non-JMS applications
* Support the development of heterogeneous applications that span operating systems, machine architectures, and computer languages
* Support messages containing Java objects
* Support messages containing Extensible Markup Language pages (see http://www.w3.org/XML).

## JMS messages

JMS messages are composed of the following parts:

* Header - All messages support the same set of header fields. Header fields contain values used by both clients and providers to identify and route messages.
* Properties - In addition to the standard header fields, messages provide a built-in facility for adding optional header fields to a message.
  + Application-specific properties - In effect, this provides a mechanism for adding application specific header fields to a message.
  + Standard properties - JMS defines some standard properties that are, in effect, optional header fields.
  + Provider-specific properties - Integrating a JMS client with a JMS provider native client may require the use of provider-specific properties. JMS defines a naming convention for these.
* Body - JMS defines several types of message body which cover the majority of messaging styles currently in use.

## Message header fields

The following subsections describe each JMS message header field. A message’s complete header is transmitted to all JMS clients that receive the message. JMS does not define the header fields transmitted to non-JMS clients.

### JMSDestination

The JMSDestination header field contains the destination to which the message is being sent.

When a message is sent this value is ignored. After completion of the send it holds the destination object specified by the sending method.

When a message is received, its destination value must be equivalent to the value assigned when it was sent.

### JMSDeliveryMode

The JMSDeliveryMode header field contains the delivery mode specified when the message was sent.

When a message is sent this value is ignored. After completion of the send, it holds the delivery mode specified by the sending method.

See Section 4.7 "Message delivery mode" for more information.

### JMSMessageID

The JMSMessageID header field contains a value that uniquely identifies each message sent by a provider.

When a message is sent, JMSMessageID is ignored. When the send method returns it contains a provider-assigned value.

A JMSMessageID is a String value which should function as a unique key for identifying messages in a historical repository. The exact scope of uniqueness is provider defined. It should at least cover all messages for a specific installation of a provider where an installation is some connected set of message routers.

All JMSMessageID values must start with the prefix ‘ID:’. Uniqueness of message ID values across different providers is not required.

Since message IDs take some effort to create and increase a message’s size, some JMS providers may be able to optimize message overhead if they are given a hint that message ID is not used by an application. Both MessageProducer and JMSProducer provide a method setDisableMessageID which allows the application to provide a hint to disable message ID. When an application sets a producer to disable message ID, it is saying that it does not depend on the value of message ID for the messages it produces. If the JMS provider accepts this hint, these messages must have the message ID set to null; if the provider ignores the hint, the message ID must be set to its normal unique value.

### JMSTimestamp

The JMSTimestamp header field contains the time a message was handed off to a provider to be sent. It is not the time the message was actually transmitted because the actual send may occur later due to transactions or other client side queueing of messages.

When a message is sent, JMSTimestampis ignored. When the send method returns, the field contains a a time value somewhere in the interval between the call and the return. It is in the format of a normal Java millis time value.

Since timestamps take some effort to create and increase a message’s size, some JMS providers may be able to optimize message overhead if they are given a hint that timestamp is not used by an application. Both MessageProducer and JMSProducer provide a method setDisableMessageTimestamp which allows the application toprovide a hint to disable timestamps. When an application sets a producer to disable timestamps it is saying that it does not depend on the value of timestamp for the messages it produces. If the JMS provider accepts this hint, these messages must have the timestamp set to zero; if the provider ignores the hint, the timestamp must be set to its normal value.

### JMSCorrelationID

A client can use the JMSCorrelationID header field to link one message with another. A typical use is to link a response message with its request message.

JMSCorrelationID can hold one of the following:

* A provider-specific message ID
* An application-specific String
* A provider-native byte[] value.

Since each message sent by a JMS provider is assigned a message ID value it is convenient to link messages via message ID. All message ID values must start with the ‘ID:’ prefix.

In some cases, an application (made up of several clients) needs to use an application-specific value for linking messages. For instance, an application may use JMSCorrelationID to hold a value referencing some external information. Application-specified values must not start with the ‘ID:’ prefix; this is reserved for provider-generated message ID values.

If a provider supports the native concept of correlation ID, a JMS client may need to assign specific JMSCorrelationID values to match those expected by non-JMS clients. A byte[] value is used for this purpose. JMS providers without native correlation ID values are not required to support byte[] values[[1]](#footnote-1) The use of a byte[] value for JMSCorrelationID is non-portable.

### JMSReplyTo

The JMSReplyTo header field contains a Destination supplied by a client when a message is sent. It is the destination where a reply to the message should be sent.

Messages sent with a null JMSReplyTo value may be a notification of some event or they may just be some data the sender thinks is of interest.

Messages sent with a JMSReplyTo value are typically expecting a response. A response may be optional; it is up to the client to decide.

### JMSRedelivered

If a client receives a message with the JMSRedeliveredindicator set, it is likely, but not guaranteed, that this message was delivered but not acknowledged in the past. In general, a provider must set the JMSRedeliveredmessage header field of a message whenever it is redelivering a message. If the field is set to true, it is an indication to the consuming application that the message may have been delivered in the past and that the application should take extra precautions to prevent duplicate processing. See Section 4.4.11"Message acknowledgment" for more information.

This header field has no meaning on send and is left unassigned by the sending method.

The JMS-defined message property JMSXDeliveryCount will be set to the number of times a particular message has been delivered. See section 3.5.11 "JMSXDeliveryCount" for more information.

### JMSType

The JMSType header field contains a message type identifier supplied by a client when a message is sent.

Some JMS providers use a message repository that contains the definitions of messages sent by applications. The type header field may reference a message’s definition in the provider’s repository.

JMS does not define a standard message definition repository nor does it define a naming policy for the definitions it contains.

Some messaging systems require that a message type definition for each application message be created and that each message specify its type. In order to work with such JMS providers, JMS clients should assign a value to JMSType whether the application makes use of it or not. This insures that the field is properly set for those providers that require it.

To ensure portability, JMS clients should use symbolic values for JMSType that can be configured at installation time to the values defined in the current provider’s message repository. If string literals are used they may not be valid type names for some JMS providers.

### JMSExpiration

When a message is sent, the JMS provider calculates its expiration time by adding the time-to-live value specified on the send method to the time the message was sent (for transacted sends, this is the time the client sends the message, not the time the transaction is committed). It is represented as a long value which is defined as the difference, measured in milliseconds, between the expiration time and midnight, January 1, 1970 UTC.

On return from the send method, the message’s JMSExpirationheader field contains this value. When a message is received its JMSExpirationheader field contains this same value.

If the time-to-live is specified as zero, the message’s JMSExpirationheader field is set to zero to indicate that the message does not expire.

When an undelivered message’s expiration time is reached, the message should be destroyed. JMS does not define a notification of message expiration.

Clients should not receive messages that have expired; however, JMS does not guarantee that this will not happen.

### JMSPriority

The JMSPriority header field contains the message’s priority.

When a message is sent this value is ignored. After completion of the send it holds the value specified by the method sending the message.

JMS defines a ten level priority value with 0 as the lowest priority and 9 as the highest. In addition, clients should consider priorities 0-4 as gradations of normal priority and priorities 5-9 as gradations of expedited priority.

JMS does not require that a provider strictly implement priority ordering of messages; however, it should do its best to deliver expedited messages ahead of normal messages.

### How message header values are set

The following table lists the message header fields supported by JMS and whether they are set by the JMS provider or by the client application.

Table 3.1 Message header field values

|  |  |  |
| --- | --- | --- |
| Header Fields | Set By | Setter method |
| JMSDestination | JMS provider send method | setJMSDestination (not for client use) |
| JMSDeliveryMode | JMS provider send method | setJMSDeliveryMode(not for client use) |
| JMSExpiration | JMS provider send method | setJMSExpiration  (not for client use) |
| JMSDeliveryTime | JMS provider send method | setJMSDeliveryTime  (not for client use) |
| JMSPriority | JMS provider send method | setJMSPriority  (not for client use) |
| JMSMessageID | JMS provider send method | setJMSMessageID  (not for client use) |
| JMSTimestamp | JMS provider send method | setJMSTimestamp  (not for client use) |
| JMSCorrelationID | Client application | setJMSCorrelationID, setJMSCorrelationIDAsBytes |
| JMSReplyTo | Client application | setJMSReplyTo |
| JMSType | Client application | setJMSType |
| JMSRedelivered | JMS provider prior to delivery | setJMSRedelivered  (not for client use) |

Message header fields that are defined as being set by the "client application" in the above table may be set by the client application, using the appropriate setter method, before the message is sent.

Message header fields that are defined as being set by the "JMS provider on send" will be available on the sending client as well as on the receiving client. If a message is sent synchronously (see section 4.6.1 "Synchronous send") then these message header fields may be accessed on the sending client when the send method returns. If a message is sent asynchronously (see section 4.6.2 "Asynchronous send") then these message header fields may be accessed on the sending client only after the completion listener has been invoked. The JMS provider sets these header fields using the appropriate setter methods. These setter methods are public to allow a JMS provider to set these fields when handling a message whose implementation is not its own. Client applications should not use these setter methods. Any values set by calling these methods prior to sending a message will be ignored and overwritten.

A client application may specify the delivery mode, priority, time to live and delivery delay of a message using appropriate methods on the MessageProducer or JMSContext object, but not by methods on the Message object itself.

Message header fields that are defined as being set by the "JMS provider prior to delivery" will be set by the JMS provider on the message delivered to the receiving client.

### Overriding message header fields

JMS permits an administrator to configure JMS to override the client specified values for delivery mode, priority, time to live and delivery delay. If this is done, the JMSDeliveryMode, JMSPriority, JMSExpiration and JMSDeliveryTime header field value must reflect the administratively specified value.

JMS does not define specifically how an administrator overrides these header field values. A JMS provider is not required to support this administrative option.

### JMSDeliveryTime

When a message is sent, the JMS provider calculates its delivery time by adding the delivery delay value specified on the send method to the time the message was sent (for transacted sends, this is the time the client sends the message, not the time the transaction is committed). It is represented as a long value which is defined as the difference, measured in milliseconds, between the delivery time time and midnight, January 1, 1970 UTC.

On return from the send method, the message’s JMSDeliveryTime header field contains this value. When a message is received its JMSDeliveryTime header field contains this same value.

A message's delivery time is the earliest time when a provider may make the message visible on the target destination and available for delivery to consumers.

Clients must not receive messages before the delivery time has been reached.

## Message properties

In addition to the header fields defined here, the Message interface contains a built-in facility for supporting property values. In effect, this provides a mechanism for adding optional header fields to a message.

Properties allow a client, via message selectors (see Section 3.8 "Message selection"), to have a JMS provider select messages on its behalf using application-specific criteria.

### Property names

Property names must obey the rules for a message selector identifier. See Section 3.8 "Message selection" for more information.

### Property values

Property values can be boolean, byte, short, int, long, float, double, and String.

### Using properties

Property values are set prior to sending a message. When a client receives a message, its properties are in read-only mode. If a client attempts to set properties at this point, a MessageNotWriteableException is thrown.

A property value may duplicate a value in a message’s body or it may not. Although JMS does not define a policy for what should or should not be made a property, application developers should note that JMS providers will likely handle data in a message’s body more efficiently than data in a message’s properties. For best performance, applications should only use message properties when they need to customize a message’s header. The primary reason for doing this is to support customized message selection.

See Section 3.8 "Message selection" for more information about JMS message properties.

### Property value conversion

Properties support the following conversion table. The marked cases must be supported. The unmarked cases must throw the JMS MessageFormatException. The String to numeric conversions must throw the java.lang.NumberFormatException if the numeric’s valueOf() method does not accept the String value as a valid representation. Attempting to read a null value as a Java primitive type must be treated as calling the primitive’s corresponding valueOf(String) conversion method with a null value.

A value set as the row type can be read as the column type.

Table 3.2 Property value conversion

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | boolean | byte | short | int | long | float | double | String |
| boolean | X |  |  |  |  |  |  | X |
| byte |  | X | X | X | X |  |  | X |
| short |  |  | X | X | X |  |  | X |
| int |  |  |  | X | X |  |  | X |
| long |  |  |  |  | X |  |  | X |
| float |  |  |  |  |  | X | X | X |
| double |  |  |  |  |  |  | X | X |
| String | X | X | X | X | X | X | X | X |

### Property values as objects

In addition to the type-specific set/get methods for properties, JMS provides the setObjectProperty/getObjectProperty methods. These support the same set of property types using the objectified primitive values. Their purpose is to allow the decision of property type to be made at execution time rather than at compile time. They support the same property value conversions.

The setObjectProperty method accepts values of Boolean, Byte, Short, Integer, Long, Float, Double and String. An attempt to use any other class must throw a JMS MessageFormatException.

The getObjectProperty method only returns values of null, Boolean, Byte, Short, Integer, Long, Float, Double and String. A null value is returned if a property by the specified name does not exist.

### Property iteration

The order of property values is not defined. To iterate through a message’s property values, use getPropertyNames to retrieve a property name enumeration and then use the various property get methods to retrieve their values.

The getPropertyNames method does not return the names of the JMS standard header fields.

### Clearing a message’s property values

A message’s properties are deleted by the clearProperties method. This leaves the message with an empty set of properties. New property entries can then be both created and read.

Clearing a message’s property entries does not clear the value of its body.

JMS does not provide a way to remove an individual property entry once it has been added to a message.

### Non-existent properties

Getting a property value for a name which has not been set is handled as if the property exists with a null value.

### JMS defined properties

JMS reserves the ‘JMSX’ property name prefix for JMS defined properties. The full set of these properties is provided in Table 3.3. This table defines:

* The name of the property
* The type of the property (integer or string)
* Whether support for the property is mandatory or optional.
* Whether the property is set by the sending client, by the provider when the message is sent, or by the provider when the message is received.
* The purpose of the property

New JMS defined properties may be added in later versions of JMS.

The Enumeration ConnectionMetaData.getJMSXPropertyNames()method returns the names of the JMSX properties supported by a connection.

JMSX properties may be referenced in message selectors whether or not they are supported by a connection. If they are not present in a message, they are treated like any other absent property. The effect of setting a message selector on a property which is set by the provider on receive is undefined.

The existence, in a particular message, of optional JMS defined properties that are set by a JMS Provider depends on how a particular provider controls use of the property. It may choose to include them in some messages and omit them in others depending on administrative or other criteria.

Table 3.3 JMS defined properties

| Name | Type | Optional or mandatory | Set By | Use |
| --- | --- | --- | --- | --- |
| JMSXUserID | String | Optional | Provider on Send | The identity of the user sending the message |
| JMSXAppID | String | Optional | Provider on Send | The identity of the application sending the message |
| JMSXDeliveryCount | int | Mandatory | Provider on Receive | The number of message delivery attempts. See section 3.5.11 "JMSXDeliveryCount". |
| JMSXGroupID | String | Optional | Client | The identity of the message group this message is part of |
| JMSXGroupSeq | int | Optional | Client | The sequence number of this message within the group; the first message is 1, the second 2,... |
| JMSXProducerTXID | String | Optional | Provider on Send | The transaction identifier of the transaction within which this message was produced |
| JMSXConsumerTXID | String | Optional | Provider on Receive | The transaction identifier of the transaction within which this message was consumed |
| JMSXRcvTimestamp | long | Optional | Provider on Receive | The time JMS delivered the message to the consumer |
| JMSXState | int | Optional | Provider | Assume there exists a message warehouse that contains a separate copy of each message sent to each consumer and that these copies exist from the time the original message was sent.  Each copy’s state is one of: 1(waiting), 2(ready), 3(expired) or 4(retained)  Since state is of no interest to producers and consumers it is not provided to either. It is only of relevance to messages looked up in a warehouse and JMS provides no API for this. |

JMSX properties ‘set by provider on send’ are available to both the producer and the consumers of the message. JSMX properties set by the provider on receive are only available to the consumers. JMSXGroupID and JMSXGroupSeq are standard properties clients should use if they want to group messages. All providers must support them.

The case of these JMSX property names must be as defined in the table above.

Unless specifically noted, the values and semantics of the JMSX properties are undefined.

### Provider-specific properties

JMS reserves the ‘JMS*\_<vendor\_name>*’ property name prefix for provider-specific properties. Each provider defines their own value of *<vendor\_name>*. This is the mechanism a JMS provider uses to make its special per message services available to a JMS client.

The purpose of provider-specific properties is to provide special features needed to support JMS use with provider-native clients. They should not be used for JMS to JMS messaging.

### JMSXDeliveryCount

When a client receives a message the mandatory JMS-defined message property JMSXDeliveryCount will be set to the number of times the message has been delivered. The first time a message is received it will be set to 1, so a value of 2 or more means the message has been redelivered.

If the JMSRedelivered message header value is set then the JMSXDeliveryCount property must always be 2 or more. See section 3.4.7 "JMSRedelivered" for more information about the JMSRedelivered message header,

The purpose of the JMSXDeliveryCount property is to allow consuming applications to identify whether a particular message is being repeatedly redelivered and take appropriate action.

The value of the JMSXDeliveryCount property is not guaranteed to be exactly correct. The JMS provider is not expected to persist this value to ensure that its value is not lost in the event of a failure.

## Message acknowledgment

All JMS messages support the acknowledge method for use when a client has specified that a JMS consumer’s messages are to be explicitly acknowledged.

If a client uses automatic acknowledgment, calls to acknowledge are ignored.

See Section 4.4.11 "Message acknowledgment" for more information.

## The Message interface

The Message interface is the root interface for all JMS messages. It defines the JMS message header fields, property facility and the acknowledge method used for all messages.

## Message selection

Many messaging applications need to filter and categorize the messages they produce.

In the case where a message is sent to a single receiver, this can be done with reasonable efficiency by putting the criteria in the message and having the receiving client discard the ones it’s not interested in.

When a message is broadcast to many clients, it becomes useful to place the criteria into the message header so that it is visible to the JMS provider. This allows the provider to handle much of the filtering and routing work that would otherwise need to be done by the application.

JMS provides a facility that allows clients to delegate message selection to their JMS provider. This simplifies the work of the client and allows JMS providers to eliminate the time and bandwidth they would otherwise waste sending messages to clients that don’t need them.

Clients attach application-specific selection criteria to messages using message properties. Clients specify message selection criteria using JMS message selector expressions.

### Message selector

A JMS message selector allows a client to specify, by message header, the messages it’s interested in. Only messages whose headers and properties match the selector are delivered. The semantics of not delivered differ a bit depending on the MessageConsumer being used. See Section 5.8 "QueueReceiver" and Section 6.11 "TopicSubscriber" for more details.

Message selectors cannot reference message body values.

A message selector matches a message when the selector evaluates to true when the message’s header field and property values are substituted for their corresponding identifiers in the selector.

#### Message selector syntax

A message selector is a String whose syntax is based on a subset of the SQL92[[2]](#footnote-2) conditional expression syntax.

If the value of a message selector is an empty string, the value is treated as a null and indicates that there is no message selector for the message consumer.

The order of evaluation of a message selector is from left to right within precedence level. Parentheses can be used to change this order.

Predefined selector literals and operator names are written here in upper case; however, they are case insensitive.

A selector can contain:

* Literals:
  + A string literal is enclosed in single quotes, with an included single quote represented by doubled single quote; for example, 'literal' and 'literal''s'. Like Java String literals, these use the Unicode character encoding.
  + An exact numeric literal is a numeric value without a decimal point, such as 57, -957, +62; numbers in the range of Java long are supported. Exact numeric literals use the Java integer literal syntax.
  + An approximate numeric literal is a numeric value in scientific notation, such as 7E3 and -57.9E2, or a numeric value with a decimal, such as 7., -95.7, and +6.2; numbers in the range of Java double are supported. Approximate literals use the Java floating-point literal syntax.
  + The boolean literals TRUE and FALSE.
* Identifiers:
  + An identifier is an unlimited-length character sequence that must begin with a Java identifier start character; all following characters must be Java identifier part characters. An identifier start character is any character for which the method Character.isJavaIdentifierStartreturns true. This includes '\_' and '$'. An identifier part character is any character for which the method Character.isJavaIdentifierPartreturns true.
  + Identifiers cannot be the names NULL, TRUE, or FALSE.
  + Identifiers cannot be NOT, AND, OR, BETWEEN, LIKE, IN, IS, or ESCAPE.
  + Identifiers are either header field references or property references. The type of a property value in a message selector corresponds to the type used to set the property. If a property that does not exist in a message is referenced, its value is NULL. The semantics of evaluating NULL values in a selector are described in Section 3.8.1.2 "Null values".
  + The conversions that apply to the get methods for properties do not apply when a property is used in a message selector expression. For example, suppose you set a property as a string value, as in the following:

myMessage.setStringProperty("NumberOfOrders", "2");

The following expression in a message selector would evaluate to false, because a string cannot be used in an arithmetic expression:

"NumberOfOrders > 1"

* + Identifiers are case sensitive.
  + Message header field references are restricted to JMSDeliveryMode, JMSPriority, JMSMessageID, JMSTimestamp, JMSCorrelationID, and JMSType. JMSMessageID, JMSCorrelationID, and JMSType values may be null and if so are treated as a NULL value.
  + Any name beginning with 'JMSX' is a JMS defined property name.
  + Any name beginning with 'JMS\_' is a provider-specific property name.
  + Any name that does not begin with 'JMS' is an application-specific property name.
* Whitespace is the same as that defined for Java: space, horizontal tab, form feed and line terminator.
* Expressions:
  + A selector is a conditional expression; a selector that evaluates to true matches; a selector that evaluates to false or unknown does not match.
  + Arithmetic expressions are composed of themselves, arithmeticoperations, identifiers with numeric values, and numeric literals.
  + Conditional expressions are composed of themselves, comparison operations, logical operations, identifiers with boolean values, and boolean literals.
* Standard bracketing () for ordering expression evaluation is supported.
* Logical operators in precedence order: NOT, AND, OR
* Comparison operators: =, >, >=, <, <=, <> (not equal)
  + Only like type values can be compared. One exception is that it is valid to compare exact numeric values and approximate numeric values (the type conversion required is defined by the rules of Java numeric promotion). If the comparison of non-like type values is attempted, the value of the operation is false. If either of the type values evaluates to NULL, the value of the expression is unknown.
  + String and Boolean comparison is restricted to = and <>. Two strings are equal if and only if they contain the same sequence of characters.
* Arithmetic operators in precedence order:
  + +, - (unary)
  + \*, / (multiplication and division)
  + +, - (addition and subtraction)
  + Arithmetic operations must use Java numeric promotion.
* arithmetic-expr1 [NOT] BETWEEN arithmetic-expr2 and arithmetic-expr3 (comparison operator)
  + "age BETWEEN 15 AND 19" is equivalent to "age >= 15 AND age <= 19"
  + "age NOT BETWEEN 15 AND 19" is equivalent to "age < 15 OR age > 19"
* identifier [NOT] IN (string-literal1, string-literal2,...) (comparison operator where identifier has a String or NULL value).
  + "Country IN (' UK', 'US', 'France')" is true for 'UK' and false for 'Peru'; it is equivalent to the expression (Country = ' UK’) OR (Country = ' US') OR (Country = ' France')
  + Country NOT IN (' UK', 'US', 'France') is false for 'UK' and true for 'Peru'; it is equivalent to the expression "NOT ((Country = ' UK') OR (Country = ' US') OR (Country = ' France'))"
  + If identifier of an IN or NOT IN operation is NULL, the value of the operation is unknown.
* identifier [NOT] LIKE *pattern-value* [ESCAPE *escape-character*] (comparison operator, where identifierhas a Stringvalue; pattern-valueis a string literal where '\_' stands for any single character; '%' stands for any sequence of characters, including the empty sequence, and all other characters stand for themselves. The optional escape-characteris a single-character string literal whose character is used to escape the special meaning of the '\_' and '%' in pattern-value.)
  + "phone LIKE ‘12%3’" is true for '123' or '12993' and false for '1234'
  + "word LIKE 'l\_se'" is true for 'lose' and false for 'loose'
  + "underscored LIKE '\\_%' ESCAPE '\'" is true for '\_foo' and false for 'bar'
  + "phone NOT LIKE '12%3'" is false for '123' and '12993' and true for '1234'
  + If identifierof a LIKE or NOT LIKE operation is NULL, the value of the operation is unknown.
* identifierIS NULL (comparison operator that tests for a null header field value or a missing property value)
  + "prop\_name IS NULL"
* identifierIS NOT NULL (comparison operator that tests for the existence of a non-null header field value or property value)
  + "prop\_name IS NOT NULL"

JMS providers are required to verify the syntactic correctness of a message selector at the time it is presented. A method providing a syntactically incorrect selector must result in a JMS InvalidSelectorException. JMS providers may also optionally provide some semantic checking at the time the selector is presented. Not all semantic checking can be performed at the time a message selector is presented, because property types are not known.

The following message selector selects messages with a message type of *car* and color of *blue* and weight greater than 2500 lbs:

"JMSType = 'car' AND color = 'blue' AND weight > 2500"

#### Null values

As noted above, header fields and property values may be NULL. The evaluation of selector expressions containing NULL values is defined by SQL 92 NULL semantics. A brief description of these semantics is provided here.

SQL treats a NULL value as unknown. Comparison or arithmetic with an unknown value always yields an unknown value.

The IS NULL and IS NOT NULL operators convert an unknown header or property value into the respective TRUE and FALSE values.

The boolean operators use three-valued logic as defined by the following tables:

Table 3.4 The definition of the AND operator

|  |  |  |  |
| --- | --- | --- | --- |
| AND | T | F | U |
| T | T | F | U |
| F | F | F | F |
| U | U | F | U |

Table 3.5 The definition of the OR operator

|  |  |  |  |
| --- | --- | --- | --- |
| OR | T | F | U |
| T | T | T | T |
| F | T | F | U |
| U | T | U | U |

Table 3.6 The definition of the NOT operator

|  |  |
| --- | --- |
| NOT |  |
| T | F |
| F | T |
| U | U |

#### Special notes

When used in a message selector JMSDeliveryMode is treated as having the values 'PERSISTENT' and 'NON\_PERSISTENT'.

Date and time values should use the standard Java long millisecond value. When a date or time literal is included in a message selector, it should be an integer literal for a millisecond value. The standard way to produce millisecond values is to use java.util.Calendar.

Although SQL supports fixed decimal comparison and arithmetic, JMS message selectors do not. This is the reason for restricting exact numeric literals to those without a decimal (and the addition of numerics with a decimal as an alternate representation for approximate numeric values).

SQL comments are not supported.

## Access to sent messages

After sending a message, a client may retain and modify it without affecting the message that has been sent. The same message object may be sent multiple times.

During the execution of its sending method, the message must not be changed by the client. If it is modified, the result of the send is undefined.

## Changing the value of a received message

When a message is received, its header field values can be changed; however, its property entries and its body are read-only, as specified in this chapter.

The rationale for the read-only restriction is that it gives JMS Providers more freedom in how they implement the management of received messages. For instance, they may return a message object that references property entries and body values that reside in an internal message buffer rather than being forced to make a copy.

A consumer can modify a received message after calling either the clearBodyor clearPropertiesmethod to make the body or properties writable. If the consumer modifies a received message, and the message is subsequently redelivered, the redelivered message must be the original, unmodified message (except for headers and properties modified by the JMS provider as a result of the redelivery, such as the JMSRedeliveredheader and the JMSXDeliveryCountproperty).

## JMS message body

JMS provides five forms of message body. Each form is defined by a message interface:

* StreamMessage - a message whose body contains a stream of Java primitive values. It is filled and read sequentially.
* MapMessage - a message whose body contains a set of name-value pairs where names are String objects and values are Java primitive types. The entries can be accessed sequentially by enumerator or randomly by name. The order of the entries is undefined.
* TextMessage - a message whose body contains a java.lang.String. The inclusion of this message type is based on our presumption that String messages will be used extensively. One reason for this is that XML will likely become a popular mechanism for representing the content of JMS messages.
* ObjectMessage - a message that contains a serializable Java object. If a collection of Java objects is needed, one of the collection classes provided in JDK 1.2 can be used.
* BytesMessage - a message that contains a stream of uninterpreted bytes. This message type is for literally encoding a body to match an existing message format. In many cases, it will be possible to use one of the other, self-defining, message types instead. Although JMS allows the use of message properties with byte messages it is typically not done since the inclusion of properties may affect the format.

### Clearing a message body

The clearBody method of Message resets the value of the message body to the ‘empty’ initial message value as set by the message type’s create method provided by Session. Clearing a message’s body does not clear its property entries.

### Read-only message body

When a message is received, its body is read only. If an attempt is made to change the body a MessageNotWriteableException must be thrown. If its body is subsequently cleared, the body is in the same state as an empty body in a newly created message.

### Conversions provided by StreamMessage and MapMessage

Both StreamMessage and MapMessage support the same set of primitive data types.

The types can be read or written explicitly using methods for each type. They may also be read or written generically as objects. For instance, a call to MapMessage.setInt("foo", 6)is equivalent to MapMessage.setObject("foo", new Integer(6)). Both forms are provided because the explicit form is convenient for static programming and the object form is needed when types are not known at compile time.

Both StreamMessageand MapMessagesupport the following conversion table. The marked cases must be supported. The unmarked cases must throw a JMS MessageFormatException. The Stringto numeric conversions must throw a java.lang.NumberFormatExceptionif the numeric’s valueOf()method does not accept the Stringvalue as a valid representation.

StreamMessageand MapMessagemust implement the Stringto boolean conversion as specified by the valueOf(String)method of Booleanas defined by the Java language.

Attempting to read a null value as a Java primitive type must be treated as calling the primitive’s corresponding valueOf(String)conversion method with a null value. Since chardoes not support a Stringconversion, attempting to read a null value as a charmust throw NullPointerException.

Getting a MapMessagefield for a field name that has not been set is handled as if the field exists with a null value.

If a read method of StreamMessageor BytesMessagethrows a MessageFormatExceptionor NumberFormatException, the current position of the read pointer must not be incremented. A subsequent read must be capable of recovering from the exception by rereading the data as a different type.

A value written as the row type can be read as the column type

Table 3.7 Conversions for StreamMessage and MapMessage

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | boolean | byte | short | char | int | long | float | double | String | byte[] |
| boolean | X |  |  |  |  |  |  |  | X |  |
| byte |  | X | X |  | X | X |  |  | X |  |
| short |  |  | X |  | X | X |  |  | X |  |
| char |  |  |  | X |  |  |  |  | X |  |
| int |  |  |  |  | X | X |  |  | X |  |
| long |  |  |  |  |  | X |  |  | X |  |
| float |  |  |  |  |  |  | X | X | X |  |
| double |  |  |  |  |  |  |  | X | X |  |
| String | X | X | X |  | X | X | X | X | X |  |
| byte[] |  |  |  |  |  |  |  |  |  | X |

### Messages for non-JMS clients

A number of enterprise messaging systems support some form of self-defining stream and/or map native message type. Although clients could use BytesMessage to construct native messages of this form, JMS provides the StreamMessage and MapMessage types as a more convenient API.

For instance, when a client is using a JMS provider that supports a native map message; and, it wishes to send a map message that can be read by both JMS and native clients, it uses a MapMessage. When the message is sent, the provider translates it into its native form. Native clients can then receive it. If a JMS provider receives it, the provider translates it back into a MapMessage.

Even when a new JMS application with newly defined messages is written, the application may choose to use StreamMessage and MapMessage to ensure that later, non-JMS clients will be able to read them.

If a JMS client sends a StreamMessage or MapMessage, it must be translated by a receiving JMS provider into an equivalent StreamMessage or MapMessage. When passed between JMS clients, a message must always retain its full form. For instance, a message sent as MapMessage must not arrive at a JMS client as a BytesMessage.

If a JMS provider receives a message created by a native client, the provider should do its best to transform it into the ‘best’ JMS message type. For instance, if it is a native stream message it should be transformed into a StreamMessage. If this is not possible, the provider is always able to transform it into a BytesMessage.

## Provider implementations of JMS message interfaces

JMS provides a set of message interfaces that define the JMS message model. It does not provide implementations of these interfaces.

Each JMS provider provides its own implementation of its Session’s message creation methods. This allows a provider to use message implementations that are tailored to its needs.

A provider must be prepared to accept, from a client, a message whose implementation is not one of its own. A message with a ‘foreign’ implementation may not be handled as efficiently as a provider’s own implementation; however, it must be handled.

The JMS message interfaces provide write/set methods for setting object values in a message body and message properties. All of these methods must be implemented to copy their input objects into the message. The value of an input object is allowed to be null and will return null when accessed. One exception to this is that BytesMessage does not support the concept of a null stream and attempting to write a null into it must throw java.lang.NullPointerException.

The JMS message interfaces provide read/get methods for accessing objects in a message body and message properties. All of these methods must be implemented to return a copy of the accessed message objects.

# JMS common facilities

## Overview

This chapter describes the JMS facilities that are shared by both the PTP and Pub/Sub domains.

## Administered objects

JMS administered objects are objects containing JMS configuration information that are created by a JMS administrator and later used by JMS clients. They make it practical to administer JMS applications in the enterprise.

Although the interfaces for administered objects do not explicitly depend on JNDI, JMS establishes the convention that JMS clients find them by looking them up in a namespace using JNDI.

An administrator can place an administered object anywhere in a namespace. JMS does not define a naming policy.

This strategy of partitioning JMS and administration provides several benefits:

* It hides provider-specific configuration details from JMS clients.
* It abstracts JMS administrative information into Java objects that are easily organized and administered from a common management console.
* Since there will be JNDI providers for all popular naming services, this means JMS providers can deliver one implementation of administered objects that will run everywhere.

An administered object should not hold on to any remote resources. Its lookup should not use remote resources other than those used by JNDI itself.

Clients should think of administered objects as local Java objects. Looking them up should not have any hidden side effects or use surprising amounts of local resources.

JMS defines two administered objects, Destination and ConnectionFactory.

It is expected that JMS providers will provide the tools an administrator needs to create and configure administered objects in a JNDI namespace. JMS provider implementations of administered objects should be both javax.naming.Referenceable and java.io.Serializable so that they can be stored in all JNDI naming contexts. In addition, it is recommended that these implementations follow the JavaBeansTM design patterns.

### Destination

JMS does not define a standard address syntax. Although this was considered, it was decided that the differences in address semantics between existing enterprise messaging products was too wide to bridge with a single syntax. Instead, JMS defines the Destination object which encapsulates provider-specific addresses.

Since Destination is an administered object it may also contain provider-specific configuration information in addition to its address.

JMS also supports a client’s use of provider-specific address names. See Section 4.4.4 "Creating Destination objects" for more information.

Destination objects support concurrent use.

### ConnectionFactory

A ConnectionFactory encapsulates a set of connection configuration parameters that has been defined by an administrator. A client uses it to create a Connection with a JMS provider.

ConnectionFactory objects support concurrent use.

## Connection

A JMS Connection is a client’s active connection to its JMS provider. It will typically allocate provider resources outside the Java virtual machine.

Connection objects support concurrent use.

A Connection serves several purposes:

* It encapsulates an open connection with a JMS provider. It typically represents an open TCP/IP socket between a client and a provider’s service daemon.
* Its creation is where client authentication takes place.
* It can specify a unique client identifier.
* It creates Session objects.
* It provides ConnectionMetaData.
* It supports an optional ExceptionListener.

Due to the authentication and communication setup done when a Connection is created, a Connection is a relatively heavyweight JMS object. Most clients will do all their messaging with a single Connection. Other more advanced applications may use several Connection objects. JMS does not architect a reason for using multiple connections (other than when a client acts as a gateway between two different providers); however, there may be operational reasons for doing so.

### Authentication

When creating a connection, a client may specify its credentials as name/password.

If no credentials are specified, the current thread’s credentials are used. At this point, the JDK does not define the concept of a thread’s default credentials; however, it is likely this will be defined in the near future. For now, the identity of the user under which the JMS client is running should be used.

### Client identifier

The preferred way to assign a client’s client identifier is for it to be configured in a client-specific ConnectionFactory and transparently assigned to the connection it creates. Alternatively, a client can set a connections’s client identifier using a provider-specific value. The facility to explicitly set a connection’s client identifier is not a mechanism for overriding the identifier that has been administratively configured. It is provided for the case where no administratively specified identifier exists. If one does exist, an attempt to change it by setting it must throw a IllegalStateException.

An application may explicitly set a connection's client identifier by calling the setClientID method on the Connection object or, if the simplified API is being used, on the JMSContext.

If a client explicitly sets a connection's client identifier it must do so immediately after creating the Connection or JMSContext and before any other action on the Connection or JMSContext is taken. After this point, setting the client identifier is a programming error that should throw an IllegalStateException.

The purpose of client identifier is to associate a connection and its objects with a state maintained on behalf of the client by a provider. By definition, the client state identified by a client identifier can only be ‘in use’ by only one client at a time. A JMS provider must prevent concurrently executing clients from using it.

This prevention may take the form of JMSExceptions thrown when such use is attempted; it may result in the offending client being blocked; or some other solution. A JMS provider must insure that such attempted ‘sharing’ of an individual client state does not result in messages being lost or doubly processed.

The only use of a client identifier defined by JMS is its optional use in identifying a durable subscription.

### Connection setup

A JMS client typically creates a Connection; one or more Session objects; and a number of MessageProducer and MessageConsumer objects. When a Connection is created, it is in stopped mode. That means that no messages are being delivered to it.

It is typical to leave the Connection in stopped mode until setup is complete. At that point the connection's start() method is called and messages begin arriving at the connection’s consumers. This setup convention minimizes any client confusion that may result from asynchronous message delivery while the client is still in the process of setting itself up.

A Connection can be started immediately and the setup can be done afterwards. Clients that do this must be prepared to handle asynchronous message delivery while they are still in the process of setting up.

A MessageProducer can send messages while a Connection is stopped.

It is important to note that clients rely on the fact that no messages are delivered by a connection until it has been started. JMS Providers must ensure that this is the case.

### Pausing delivery of incoming messages

A connection’s delivery of incoming messages can be temporarily stopped using its stop method. It can be restarted using its start method. When stopped, delivery to all the connection’s MessageConsumer objects is inhibited: synchronous receives block, and messages are not delivered to any message listeners.

Stopping a connection has no affect on its ability to send messages. Stopping a stopped connection and starting a started connection are ignored.

A stop method call must not return until delivery of messages has paused. This means a client can rely on the fact that none of its message listeners will be called and all threads of control waiting for receive to return will not return with a message until the connection is restarted. The receive timers for a stopped connection continue to advance so receives may time out and return a null message while the connection is stopped.

If any message listeners are running when stop is invoked, stop must wait until all of them have returned before it may return. While these message listeners are completing, they must have the full services of the connection available to them.

A message listener must not attempt to stop its own connection as this would lead to deadlock. The JMS provider must detect this and throw a javax.jms.IllegalStateException.

### Closing a Connection

Since a provider typically allocates significant resources outside the JVM on behalf of a connection, clients should close them when they are not needed. Relying on garbage collection to eventually reclaim these resources may not be timely enough.

A close terminates all pending message receives on the connection’s session’s consumers. The receives may return with a message or null depending on whether there was a message or not available at the time of the close.

Note that in this case, the message consumer will likely get an exception if it is attempting to use the facilities of the now closed connection while processing its last message. A developer must take this ‘last message’ case into account when writing a message consumer. It bears repeating that the message consumer cannot rely on a null return value to indicate this ‘last message’ case.

If one or more of the connection’s session’s message listeners is processing a message at the point when connection close is invoked, all the facilities of the connection and its sessions must remain available to those listeners until they return control to the JMS provider.

When connection close is invoked it should not return until message processing has been shut down in an orderly fashion. This means that all message listeners that may have been running have returned, and that all pending receives have returned.

A message listener must not attempt to close its own connection as this would lead to deadlock. The JMS provider must detect this and throw a javax.jms.IllegalStateException.

If a connection is closed, there is no need to close its constituent sessions, message producers, messages consumers or queue browsers. The connection close is sufficient to signal the JMS provider that all resources for the connection should be released.

The Connection interface extends the java.lang.AutoCloseable interface. This means that applications which create the connection in a try-with-resources statement do not need to call the close method when the connection is no longer needed. Instead the connection will be closed automatically at the end of the statement. The use of a try-with-resources statement also simplifies the handling of any exceptions thrown by the close method. See the Java Tutorials[[3]](#footnote-3) for more information about the try-with-resources statement.

Closing a connection must rollback the transactions in progress on its transacted sessions[[4]](#footnote-4). Closing a connection does NOT force an acknowledge of client acknowledged sessions. Invoking the acknowledge method of a received message from a closed connection’s sessions must throw an IllegalStateException. These semantics insure that closing a connection does not cause messages to be lost for queues and durable subscriptions which require reliable processing by a subsequent execution of their JMS client.

Once a connection has been closed, an attempt to use it or its sessions or their message consumers and producers must throw an IllegalStateException (calls to the close method of these objects must be ignored). It is valid to continue to use message objects created or received via the connection with the exception of a received message’s acknowledge method.

Closing a closed connection must NOT throw an exception.

### Sessions

A Connection is a factory for Session objects that use its underlying connection to a JMS provider for producing and consuming messages.

### ConnectionMetaData

A Connection provides a ConnectionMetaData object. This object provides the latest version of JMS supported by the provider as well as the provider’s product name and version.

It also provides a list of the JMS defined property names supported by the connection.

### ExceptionListener

If a JMS provider detects a problem with a connection, it will inform the connection’s ExceptionListener, if one has been registered. To retrieve an ExceptionListener, the JMS provider calls the connection’s getExceptionListener()method. This method returns the ExceptionListenerfor the connection. If no ExceptionListeneris registered, the value null is returned*.* The connection can then use the listener by calling the listener’s onException()method, passing it a JMSExceptiondescribing the problem.

This allows a client to be asynchronously notified of a problem. Some connections only consume messages, so they would have no other way to learn their connection has failed.

A Connection serializes execution of its ExceptionListener.This means that if a connection encounters multiple problems and therefore needs to call its ExceptionListener multiple times, then it will only invoke onException from one thread at a time. However if the same ExceptionListener is registered with multiple connections then it is undefined whether these connections could call onException from different threads simultaneously.

A JMS provider should attempt to resolve connection problems itself prior to notifying the client of them.

The exceptions delivered to ExceptionListenerare those that have no other place to be reported. If an exception is thrown on a JMS call it, by definition, must not be delivered to an ExceptionListener(in other words, ExceptionListeneris not for the purpose of monitoring all exceptions thrown by a connection).

There is no restriction on the use of the JMS API by the listener's onException method. However since that method will only be called when there is a serious problem with the connection, any attempt to use that connection may fail and cause exceptions.

## Session

A JMS Session is a single threaded context[[5]](#footnote-5) for producing and consuming messages. Although it may allocate provider resources outside the Java virtual machine, it is considered a light-weight JMS object.

A Session serves several purposes:

* It is a factory for MessageProducer and MessageConsumer objects.
* It is a factory for TemporaryTopic and TemporaryQueue objects.
* It provides a way to create Queueor Topicobjects for those clients that need to dynamically manipulate provider-specific destination names.
* It supplies provider-optimized message factories.
* It supports a single series of transactions that combine work spanning this session’s producers and consumers into atomic units.
* It defines a serial order for the messages it consumes and the messages it produces.
* It retains messages it consumes until they have been acknowledged.
* It serializes execution of MessageListener objects registered with it.
* It is a factory for QueueBrowser objects.

### Closing a Session

Since a provider may allocate some resources on behalf of a session outside the JVM, clients should close them when they are not needed. Relying on garbage collection to eventually reclaim these resources may not be timely enough. The same is true for the MessageProducer and MessageConsumer objects created by a session.

Session close terminates all message processing on the session. It must handle the shutdown of pending receives by the session’s consumers or a running message listener as described in Closing a Connection.

Session close is the only session method that may be invoked from a thread of control separate from the one which is currently controlling the session.

When session close is invoked it should not return until its message processing has been shut down in an orderly fashion. This means that none of its message listeners are running, and that if there is a pending receive, it has returned with either null or a message.

A message listener must not attempt to close its own session as this would lead to deadlock. The JMS provider must detect this and throw a javax.jms.IllegalStateException.

When a session is closed, there is no need to close its constituent message producers, message consumers or queue browsers. The session close is sufficient to signal the JMS provider that all resources for the session should be released.

Note that closing a connection will cause any sessions created from it to be closed, so, although a session should be closed when no longer needed, there is no need to close a session immediately prior to closing its connection.

The Session interface extends the java.lang.AutoCloseable interface. This means that applications which create the session in a try-with-resources statement do not need to call the close method when the connection is no longer needed. Instead the session will be closed automatically at the end of the statement. The use of a try-with-resources statement also simplifies the handling of any exceptions thrown by the close method.

Closing a transacted session must rollback its transaction in progress. Closing a client-acknowledged session does NOT force an acknowledge.

Once a session has been closed, an attempt to use it or its message consumers and producers must throw an IllegalStateException (calls to the close method of these objects must be ignored). It is valid to continue to use message objects created or received via the session with the exception of a received message’s acknowledge method.

Closing a closed session must NOT throw an exception.

### MessageProducer and MessageConsumer Creation

A session can create and service multiple MessageProducer and MessageConsumer objects. See Section 4.5 "MessageConsumer" and Section 4.6 "MessageProducer" for information on their creation and use.

Although a session may create multiple producers and consumers, they are restricted to serial use. In effect, only a single logical thread of control can use them. This is explained in more detail later.

### Creating temporary destinations

Although sessions are used to create temporary destinations, this is only for convenience. Their scope is actually the entire connection. Their lifetime is that of their connection and any of the connection’s sessions are allowed to create a MessageConsumer for them.

Temporary destinations (TemporaryQueueor TemporaryTopicobjects) are destinations that are system-generated uniquely for their connection. Only their own connection is allowed to create MessageConsumer objects for them.

One typical use for a TemporaryDestination is as the JMSReplyTo destination for service requests.

Each TemporaryQueueor TemporaryTopicobject object is unique. It cannot be copied.

Since temporary destinations may allocate resources outside the JVM, they should be deleted if they are no longer needed. They will be automatically deleted when they are garbage collected or when their connection is closed.

### Creating Destination objects

Most clients will use Destination objects that are JMS administered objects that they have looked up via JNDI. This is the most portable approach.

Some specialized clients may need to create Destination objects by dynamically manufacturing one using a provider specific destination name. Sessions provide a JMS provider-specific method for doing this.

### Optimized message implementations

A session provides the following methods to create messages: createMessage, createBytesMessage, createMapMessage, createObjectMessage, createStreamMessage and createTextMessage.

These methods allow the JMS provider to create message implementations which are optimized for that particular provider and allow the provider to minimize its overhead for handling messages.

However the fact that these methods are provided on a session does not mean that messages must be sent using a message producer created from the same session. Messages may be sent using any session, not just the session used to create the message.

Furthermore, sessions must be capable of sending all JMS messages regardless of how they may be implemented. See section 3.12 "Provider implementations of JMS message interfaces".

### Conventions for using a session

Sessions are designed for serial use by one thread at a time. The only exception to this occurs during the orderly shutdown of the session or its connection. See Section 4.3.5 "Closing a Connection" and Section 4.4.1 "Closing a Session" for further details.

One typical use is to have a thread block on a synchronous MessageConsumer until a message arrives. The thread may then use one or more of the session’s MessageProducer objects.

It is erroneous for a client to use a thread of control to attempt to synchronously receive a message if there is already a client thread of control waiting to receive a message in the same session.

Another typical use is to have one thread set up a session by creating its producers and one or more asynchronous consumers. In this case, the message producers are exclusively for the use of the consumer’s message listeners. Since the session serializes execution of its consumers' message listeners, they can safely share the resources of their session.

If a connection is left in stopped mode while its sessions are being set up, a client does not have to deal with messages arriving before the client is fully prepared to handle them. This is the preferred strategy because it eliminates the possibility of unanticipated conflicts between setup and message processing. It is possible to create and set up a session while a connection is receiving messages. In this case, more care is required to ensure that a session’s message producers, message consumers and message listeners are created in the right order. For instance, a bad order may cause a MessageListener to use a MessageProducer that has yet to be created; or messages may arrive in the wrong order due to the order in which MessageListener objects are registered.

If a client desires to have one thread producing messages while others consume them, the client should use a separate session for its producing thread.

Once a connection has been started, all its sessions with a registered message listener are dedicated to the thread of control that delivers messages to them. It is erroneous for client code to use such a session from another thread of control. The only exception to this is the use of the session or connection close method.

One consequence of the session’s single-thread-of-control restriction is that a session with message listeners cannot also be used to synchronously receive messages. Either the session is dedicated to the thread of control used for delivery to message listeners, or it is dedicated to a thread of control initiated by client code. It is erroneous to attempt to combine both in the same session.

Another consequence is that a connection must be in stopped mode to set up a session with more than one message listener. The reason is that when a connection is actively delivering messages, once the first message listener for a session has been registered, the session is now controlled by the thread of control that delivers messages to it. At this point a client thread of control cannot be used to further configure the session.

It should be natural for most clients to partition their work into sessions. This model allows clients to start simply and incrementally add message processing complexity as their need for concurrency grows.

Since a JMSContext incorporates a Session it is subject to the same threading restrictions as a Session. For more information, and an exception to this, see section 11.2.8 "Threading restrictions on a JMSContext".

Additional threading restrictions apply to applications which perform an asynchronous send. See section 4.6.2 "Asynchronous send" and in particular section 4.6.2.6 "Restrictions on threading"

### Transactions

A Session may be optionally specified as transacted. Each transacted session supports a single series of transactions. Each transaction groups a set of produced messages and a set of consumed messages into an atomic unit of work. In effect, transactions organize a session’s input message stream and output message stream into series of atomic units. When a transaction commits, its atomic unit of input is acknowledged and its associated atomic unit of output is sent. If a transaction rollback is done, its produced messages are destroyed and its consumed messages are automatically recovered. For more information on session recovery see Section 4.4.11 "Message acknowledgment".

A transaction is completed using either its session’s commit() or rollback() method. The completion of a session’s current transaction automatically begins the next. The result is that a transacted session always has a current transaction within which its work is done.

JTS or some other transaction monitor facility may be used to combine a session’s transaction with transactions on other resources (databases, other JMS Sessions, etc.). Since Java distributed transactions are controlled via the JTA transaction demarcation API, use of the session’s commit and rollback methods in this context throws a JMS TransactionInProgressException.

### Distributed transactions

JMS does not require that a provider support distributed transactions; however, it does define that if a provider supplies this support it should be done via the JTA XAResource API.

A JMS provider may also be a distributed transaction monitor. If it is, it should provide control of the transaction via the JTA API.

Although it is possible for a JMS client to handle distributed transactions directly, it is recommended that JMS clients avoid doing this. JMS clients that use the XA-based interfaces described in Chapter 8 "JMS application server facilities" may not be portable across different JMS implementations, because these interfaces are optional. Support for JTA in JMS is targeted at systems vendors who will be integrating JMS into their application server products. See Chapter 8 "JMS application server facilities" for more information.

### Multiple sessions

A client may create multiple sessions. Each session is an independent producer and consumer of messages.

For Pub/Sub, if two sessions each have a TopicSubscriberthat subscribes to the same topic, each subscriber is given each message. Delivery to one subscriber does not block if the other gets behind.

For PTP, JMS does not specify the semantics of concurrent QueueReceiverobjectsfor the same queue; however, JMS does not prohibit a provider from supporting this. Therefore, message delivery to multiple QueueReceiverobjectswill depend on the JMS provider’s implementation. Applications that depend on delivery to multiple QueueReceiverobjectsare not portable

### Message order

JMS clients need to understand when they can depend on message order and when they cannot.

#### Order of message receipt

Messages consumed by a session define a serial order. This order is important because it defines the effect of message acknowledgment. See Section 4.4.11 "Message acknowledgment" for more details. The messages for each of a session’s consumers are interleaved in a session’s input message stream.

JMS defines that messages sent by a session to a destination must be received in the order in which they were sent (see Section 4.4.10.2 "Order of message sends" for a few qualifications). This defines a partial ordering constraint on a session’s input message stream.

JMS does not define order of message receipt across destinations or across a destination’s messages sent from multiple sessions. This aspect of a session’s input message stream order is timing-dependent. It is not under application control.

#### Order of message sends

Although clients loosely view the messages they produce within a session as forming a serial stream of sent messages, the total ordering of this stream is not significant. The only ordering that is visible to receiving clients is the order of messages a session sends to a particular destination. Several things can affect this order:

* Messages of higher priority may jump ahead of previous lower-priority messages.
* Messages with a later delivery time may be delivered after messages with an earlier delivery time.
* A client may not receive a NON\_PERSISTENT message due to a JMS provider failure.
* If both PERSISTENT and NON\_PERSISTENT messages are sent to a destination, order is only guaranteed within delivery mode. That is, a later NON\_PERSISTENT message may arrive ahead of an earlier PERSISTENT message; however, it will never arrive ahead of an earlier NON\_PERSISTENT message with the same priority.
* A client may use a transacted session to group its sent messages into atomic units (the producer component of a JMS transaction). A transaction’s order of messages to a particular destination is significant. The order of sent messages across destinations is not significant. See Section 4.4.7 "Transactions" for more information.

### Message acknowledgment

If a session is transacted, message acknowledgment is handled automatically by commit, and recovery is handled automatically by rollback.

If a session is not transacted, there are three acknowledgment options and recovery is handled manually:

* DUPS\_OK\_ACKNOWLEDGE - This option instructs the session to lazily acknowledge the delivery of messages. This is likely to result in the delivery of some duplicate messages if JMS fails, it should only be used by consumers that are tolerant of duplicate messages. Its benefit is the reduction of session overhead achieved by minimizing the work the session does to prevent duplicates.
* AUTO\_ACKNOWLEDGE - With this option, the session automatically acknowledges a client’s receipt of a message when it has either successfully returned from a call to receive or the message listener it has called to process the message successfully returns.
* CLIENT\_ACKNOWLEDGE - With this option, a client acknowledges a message by calling the message’s acknowledge method. Acknowledging a consumed message automatically acknowledges the receipt of all messages that have been delivered by its session.

When CLIENT\_ACKNOWLEDGE mode is used, a client may build up a large number of unacknowledged messages while attempting to process them. A JMS provider should provide administrators with a way to limit client over-run so that clients are not driven to resource exhaustion and ensuing failure when some resource they are using is temporarily blocked.

A session’s recover method is used to stop a session and restart it with its first unacknowledged message. In effect, the session’s series of delivered messages is reset to the point after its last acknowledged message. The messages it now delivers may be different from those that were originally delivered due to message expiration, the arrival of higher-priority messages, or the delivery of messages which could not previously be delivered as they had not reached their specified delivery time.

A session must set the JMSRedelivered header and increment the JMSXDeliveryCount property of messages it redelivers due to a recovery

### Duplicate delivery of messages

A JMS provider must never deliver a second copy of an acknowledged message.

When a client uses the AUTO\_ACKNOWLEDGE mode, it is not in direct control of message acknowledgment. Since such clients cannot know for certain if a particular message has been acknowledged, they must be prepared for redelivery of the last consumed message. This can be caused by the client completing its work just prior to a failure that prevents the message acknowledgment from occurring. Only a session’s last consumed message is subject to this ambiguity. The JMSRedeliveredmessage header field will be set for a message redelivered under these circumstances, and the JMSXDeliveryCount property will be incremented.

### Duplicate production of messages

JMS providers must never produce duplicate messages. This means that a client that produces a message can rely on its JMS provider to ensure that consumers of the message will receive it only once. No client error can cause a provider to duplicate a message.

If a failure occurs between the time a client commits its work on a Session and the commit method returns, the client cannot determine if the transaction was committed or rolled back. The same ambiguity exists when a failure occurs between the non-transactional send of a PERSISTENT message and the return from the sending method.

It is up to a JMS application to deal with this ambiguity. In some cases, this may cause a client to produce functionally duplicate messages.

A message that is redelivered due to session recovery is not considered a duplicate message.

### Serial execution of client code

Even though the Java language provides built-in support for multithreading, writing multithreaded programs is still more difficult than writing singlethreaded ones.

For this reason, JMS does not cause concurrent execution of client code unless a client explicitly requests it. One way this is done is to define that a session serializes all asynchronous delivery of messages.

To receive messages asynchronously, a client registers an object that implements the JMS MessageListener interface with a MessageConsumer or JMSConsumer. *In effect, a session uses a single thread to run all its message listeners*. While the thread is busy executing one listener, all other messages to be asynchronously delivered to the session must wait.

### Concurrent message delivery

Clients that desire concurrent delivery can use multiple sessions. In effect, each session’s listener thread runs concurrently. While a listener on one session is executing, a listener on another session may also be executing.

Note that JMS itself does not provide the facilities for concurrently processing a topic’s message set (the messages delivered to a single consumer). A client could use a single consumer and implement all the multithreading logic needed to concurrently process the messages; however, it is not possible to do this reliably, because JMS does not have the transaction facilities needed to handle the concurrent transactions this would require.

## MessageConsumer

A client uses a MessageConsumerto receive messages from a destination. A MessageConsumeris created by passing a Queueor Topicto a session'screateConsumermethod.

A consumer can be created with a message selector. This allows the client to restrict the messages delivered to the consumer to those that match the selector. See Section 3.8.1 "Message selector" for more information.

A client may either synchronously receive a consumer’s messages or have the provider asynchronously deliver them as they arrive.

### Synchronous delivery

A client can request the next message from a MessageConsumer using one of its receive methods. There are several variations of receive that allow a client to poll or wait for the next message.

### Asynchronous delivery

A client can register an object that implements the JMS MessageListener interface with a MessageConsumer. As messages arrive for the consumer, the provider delivers them by calling the listener’s onMessage method.

It is possible for a listener to throw a RuntimeException; however, this is considered a client programming error. Well behaved listeners should catch such exceptions and attempt to divert messages causing them to some form of application-specific ‘unprocessable message’ destination.

The result of a listener throwing a RuntimeException depends on the session’s acknowledgment mode.

* AUTO\_ACKNOWLEDGE or DUPS\_OK\_ACKNOWLEDGE - the message will be immediately redelivered. The number of times a JMS provider will redeliver the same message before giving up is provider-dependent. The JMSRedeliveredmessage header field will be set, and the JMSXDeliveryCount message property incremented, for a message redelivered under these circumstances.
* CLIENT\_ACKNOWLEDGE - the next message for the listener is delivered. If a client wishes to have the previous unacknowledged message redelivered, it must manually recover the session.
* Transacted Session - the next message for the listener is delivered. The client can either commit or roll back the session (in other words, a RuntimeExceptiondoes not automatically rollback the session).

JMS providers should flag clients with message listeners that are throwing RuntimeException as possibly malfunctioning.

See Section 4.4.14 "Serial execution of client code" for information about how onMessage calls are serialized by a session.

## MessageProducer

A client uses a MessageProducerto send messages to a Destination. A MessageProduceris created by passing a Queueor Topicto a session’s createProducermethod.

A client also has the option of creating a producer without supplying a destination. In this case, a destination must be input on every send operation. A typical use for this style of producer is to send replies to requests using the request’s JMSReplyTodestination.

A client may send a message either synchronously or asynchronously. For more details see sections 4.6.1 "Synchronous send" and 4.6.2 "Asynchronous send".

A client can specify a default delivery mode, priority, time-to-live and delivery delay for messages sent by a producer.

A client can also specify delivery mode, priority, and time-to-live per message.

Each time a client creates a MessageProducer, it defines a new sequence of messages that have no ordering relationship with the messages it has previously sent.

See Section 3.4.9 "JMSExpiration" for more information on time-to-live. See Section  3.4.10 "JMSPriority" for more information on priority. See Section 3.4.13 "JMSDeliveryTime" for more information on delivery delay.

### Synchronous send

The following methods on MessageProducer may be used to send a message synchronously:

void send(Message message)

void send(Destination destination, Message message)

void send(Destination destination, Message message, int deliveryMode, int priority, long timeToLive)

void send(Message message, int deliveryMode, int priority, long timeToLive)

These methods will block until the message has been sent. If necessary the call will block until a confirmation message has been received back from the JMS server.

### Asynchronous send

Clients may alternatively send a message using the following methods which permit the JMS provider to perform part of the work involved in sending the message in a separate thread. JMS refers to this as an "asynchronous send".

send(Destination destination, Message message, CompletionListener completionListener)

send(Destination destination, Message message, int deliveryMode, int priority, long timeToLive, CompletionListener completionListener)

send(Message message, CompletionListener completionListener)

send(Message message, int deliveryMode, int priority, long timeToLive, CompletionListener completionListener)

When the 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 normal synchronous send had been performed. An application which requires this degree of confidence must therefore wait for the callback to be invoked before continuing.

The following information is intended to give an indication of how an asynchronous send would typically be implemented.

In some JMS providers, a normal synchronous send involves sending the message to a remote JMS server and then waiting for an acknowledgement to be received before returning. It is expected that such a provider would implement 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 the CompletionListener's onException method.

In those cases where the JMS specification permits a lower level of reliability, a normal synchronous send might not wait for an acknowledgement. In that case it is expected that an asynchronous send would be similar to a synchronous send: the JMS provider would send the message to the remote JMS server and then return without waiting for an acknowledgement. However the JMS provider would still notify the application that the send had completed by invoking the onCompletion method on the application-specified CompletionListener object.

It is up to the JMS provider to decide exactly what is performed in the calling thread and what, if anything, is performed asynchronously, so long as it satisfies the requirements given in the following sections:

#### Quality of service

After the send operation has completed successfully, which means that the message has been successfully sent with the same degree of confidence as if a normal synchronous send had been performed, the JMS provider must invoke the CompletionListener's onCompletion method.The CompletionListener must not be invoked earlier than this.

#### Exceptions

If an exception is encountered during the call to the send method then an appropriate exception should be thrown in the thread that is calling the send method. In this case the JMS provider must not invoke the CompletionListener's onCompletion or onException method.

If an exception is encountered which cannot be thrown in the thread that is calling the send method then the JMS provider must call the CompletionListener's onException method.

In both cases if an exception occurs it is undefined whether or not the message was successfully sent.

#### Message order

If the same MessageProducer or JMSContext is used to send multiple messages then JMS message ordering requirements (see section 4.4.10 "Message order") must be satisfied. This applies even if a combination of synchronous and asynchronous sends has been performed. The application is not required to wait for an asynchronous send to complete before sending the next message.

#### Close, commit or rollback

If the close method is called on the MessageProducer, Session, Connection or JMSContext object then the JMS provider must block until any incomplete send operations have been completed and all CompletionListener callbacks have returned before closing the object and returning.

If the session is transacted (uses a local transaction) then when the commit or rollback method is called the JMS provider must block until any incomplete send operations have been completed and all CompletionListener callbacks have returned before performing the commit or rollback.

Incomplete sends should be allowed to complete normally unless an error occurs.

A CompletionListener callback method must not call close on its own JMSContext, Connection, Session or MessageProducer or call commit or rollback on its own JMSContext or Session. Doing so will cause the close, commit or rollback to throw an IllegalStateException or IllegalStateRuntimeException (depending on the method signature).

#### Restrictions on usage in Java EE

An asynchronous send is not permitted in a Java EE EJB or web container. If the application component violates this restriction the send method may throw a JMSException or JMSRuntimeException (depending on the method signature).

#### Message headers

JMS defines a number of message header fields and message properties which must be set by the "JMS provider on send". See section 3.4.11 "How message header values are set" and section 3.5.9 "JMS defined properties". If the send is asynchronous these fields and properties may be accessed on the sending client only after the CompletionListener has been invoked. If the CompletionListener's onException method is called then the state of these message header fields and properties is undefined. See also section 4.6.2.8 "Restrictions on the use of the Message object" below.

#### Restrictions on threading

Applications that perform an asynchronous send must confirm to the threading restrictions defined in section 4.4.6 "Conventions for using a session". This means that the session may be used by only one thread at a time.

Setting a CompletionListener does not cause the session to be dedicated to the thread of control which calls the CompletionListener. The application thread may therefore continue to use the session after performing an asynchronous send. However the CompletionListener's callback methods must not use the session if an application thread might be using the session at the same time.

#### Use of the CompletionListener by the JMS provider

A session will only invoke one CompletionListener callback method at a time. For a given MessageProducer or JMSContext, callbacks (both onCompletion and onException) will be performed in the same order as the corresponding calls to the asynchronous send method.

A JMS provider must not invoke the CompletionListener from the thread that is calling the asynchronous send method.

#### Restrictions on the use of the Message object

Applications which perform an asynchronous send must take account of the restriction that a Message object is designed to be accessed by one logical thread of control at a time and does not support concurrent use. See section 2.8 "Multi-threading".

After the send method has returned, the application must not attempt to read the headers, properties or body of the Message object until the CompletionListener's onCompletion or onException method has been called. This is because the JMS provider may be modifying the Message object in another thread during this time.

A JMS provider may throw a JMSException if the application attempts to access or modify the Message object after the send method has returned and before the CompletionListener has been invoked. If the JMS provider does not throw an exception then the behaviour is undefined.

## Message delivery mode

JMS supports two modes of message delivery.

* The NON\_PERSISTENT mode is the lowest overhead delivery mode because it does not require that the message be logged to stable storage. A JMS provider failure can cause a NON\_PERSISTENT message to be lost.
* The PERSISTENT mode instructs the JMS provider to take extra care to ensure the message is not lost in transit due to a JMS provider failure.

A JMS provider must deliver a NON\_PERSISTENT message at-most-once. This means it may lose the message, but it must not deliver it twice.

A JMS provider must deliver a PERSISTENT message once-and-only-once. This means a JMS provider failure must not cause it to be lost, and it must not deliver it twice.

PERSISTENT (once-and-only-once) and NON\_PERSISTENT (at-most-once) message delivery are a way for a JMS client to select between delivery techniques that may lose a messages if a JMS provider dies and those which take extra effort to ensure that messages can survive such a failure. There is typically a performance/reliability trade-off implied by this choice. When a client selects the NON\_PERSISTENT delivery mode, it is indicating that it values performance over reliability; a selection of PERSISTENT reverses the requested trade-off.

The use of PERSISTENT messages does not guarantee that all messages are always delivered to every eligible consumer. See Section 4.10 "Reliability" for further discussion on this topic.

## Message time-to-live

A client can specify a time-to-live value in milliseconds for each message it sends. This is used to determine the message's expiration time which is calculated by adding the time-to-live value specified on the send method to the time the message was sent (for transacted sends, this is the time the client sends the message, not the time the transaction is committed).

A JMS provider should do its best to accurately expire messages; however, JMS does not define the accuracy provided. It is not acceptable to simply ignore time-to-live.

For more information on message expiration, see Section 3.4.9 "JMSExpiration".

## Exceptions

JMSException is the base class for all JMS exceptions. See Chapter 7 "JMS exceptions" for more information.

## Reliability

Most clients should use producers that produce PERSISTENT messages. This ensures once-and-only-once message delivery for messages delivered from a queue or a durable subscription.

In some cases, an application may only require at-most-once message delivery for some of its messages. This is accomplished by publishing NON\_PERSISTENT messages. These messages typically have lower overhead; however, they may be lost if a JMS provider fails. Both PERSISTENT and NON\_PERSISTENT messages can be published to the same destination.

Normally, a consumer fully processes each message before acknowledging its receipt to JMS. This insures that JMS does not discard a partially processed message due to machine failure, etc. A consumer accomplishes this by using either a transacted or CLIENT\_ACKNOWLEDGE session. Unacknowledged messages redelivered due to system failure must have the JMSRedeliveredmessage header field set, and the JMSXDeliveryCount incremented, by the JMS provider, as described in sections 3.4.7 "JMSRedelivered" and 3.5.11 "JMSXDeliveryCount"

If a NON\_PERSISTENT message is delivered to a durable subscription or a queue, delivery is not guaranteed if the durable subscription becomes inactive (that is, if it has no current subscriber) or if the JMS provider is shut down and later restarted.

It is expected that important messages will be produced with a PERSISTENT delivery mode within a transaction and will be consumed within a transaction from a nontemporary queue or a durable subscription.

When this is done, applications have the highest level of assurance that a message has been properly produced, reliably delivered, and accurately consumed. Non-transactional production and consumption can also achieve the same level of assurance; however, this requires careful programming.

A JMS provider may have resource restrictions that limit the number of messages that can be held for high-volume destinations or non-responsive clients. If messages are dropped due to resource limits, this is usually a serious administrative issue that needs attention. Correct functioning of JMS requires that clients are responsive and that adequate resources to service them are available.

Once-and-only-once message delivery, as described in this specification, has the important caveat that it does not cover message destruction due to message expiration or other administrative destruction criteria. It also does not cover loss due to resource restrictions. Configuration of adequate resources and processing power for JMS applications is the job of administrators, who must be aware of their JMS provider’s reliability features.

NON\_PERSISTENT messages, nondurable subscriptions, and temporary destinations are by definition unreliable. A JMS provider shutdown or failure will likely cause the loss of NON\_PERSISTENT messages and the loss of messages held by temporary destinations and nondurable subscriptions. The termination of an application will likely cause the loss of messages held by nondurable subscriptions and temporary destinations of the application.

## Method inheritance across messaging domains

As a result of unifying the domains, some methods that are not appropriate to a domain may be inherited in the domain-specific classes. For example, the Sessioninterface has the method createQueueBrowser*.* Since TopicSessioninherits from the Sessioninterface, TopicSessioninherits the createQueueBrowsermethod, though that method must not be used by a topic, as topics do not support queue browsers. Table 4.1outlines these instances.

If a application attempts to call any of the methods listed, the JMS provider must throw an IllegalStateException.

Table 4.1 methods that throw an IllegalStateException

| Interface | Method |
| --- | --- |
| QueueConnection | createDurableConnectionConsumer |
| QueueSession | createDurableSubscriber |
|  | createDurableConsumer |
|  | createSharedConsumer |
|  | createTemporaryTopic |
|  | createTopic |
|  | unsubscribe |
| TopicSession | createQueueBrowser |
|  | createQueue |
|  | createTemporaryQueue |

## Delivery delay

A client can specify a delivery delay value in milliseconds for each message it sends. This is used to determine the message's delivery time which is calculated by adding the delivery delay value specified on the send method to the time the message was sent (for transacted sends, this is the time the client sends the message, not the time the transaction is committed).

A message's delivery time is the earliest time when a JMS provider may deliver the message to a consumer. The provider must not deliver messages before the delivery time has been reached.

If a message is published to a topic, it will only be added to a durable or non-durable subscription on that topic if the subscription exists at the time the message is sent.

For more information on message delivery delay, see Section 3.4.13 "JMSDeliveryTime".

# JMS point-to-point model

## Overview

Point-to-point systems are about working with queues of messages. They are point-to-point in that a client sends a message to a specific queue. Some PTP systems blur the distinction between PTP and Pub/Sub by providing system clients that automatically distribute messages.

It is common for a client to have all its messages delivered to a single queue.

Like any generic mailbox, a queue can contain a mixture of messages. And, like real mailboxes, creating and maintaining each queue is somewhat costly. Most queues are created administratively and are treated as static resources by their clients.

The JMS PTP model defines how a client works with queues: how it finds them, how it sends messages to them, and how it receives messages from them.

This chapter describes the semantics of the Point-to-Point model. A JMS provider that supports the Point-to-Point model must deliver the semantics described here.

Whether a JMS client program uses the PTP domain-specific interfaces, or the common interfaces that are described in Chapter 4, “JMS Common Facilities, the client program *must* be guaranteed the same behavior.

Table 5.1 shows the interfaces that are specific to the PTP domain and the JMS common interfaces. The common interfaces are preferred for creating JMS application programs, because they are domain-independent.

Table 5.1 PTP domain interfaces and JMS common interfaces

|  |  |
| --- | --- |
| PTP domain interfaces | JMS common interfaces *preferred* |
| QueueConnectionFactory | ConnectionFactory |
| QueueConnection | Connection |
| Queue | Destination |
| QueueSession | Session |
| QueueSender | MessageProducer |
| QueueReceiver | MessageConsumer |

## Queue management

JMS does not define facilities for creating, administering, or deleting long-lived queues (it does provide such a mechanism for temporary queues). Since most clients use statically defined queues this is not a problem.

## Queue

A Queue object encapsulates a provider-specific queue name. It is the way a client specifies the identity of queue to JMS methods.

The actual length of time messages are held by a queue and the consequences of resource overflow are not defined by JMS.

See Section 4.2 "Administered objects" for more information about JMS Destination objects.

## TemporaryQueue

A TemporaryQueue is a unique Queue object created for the duration of a Connection or QueueConnection. It is a system-defined queue that can only be consumed by the Connection or QueueConnection that created it.

See Section 4.4.3 "Creating temporary destinations" for more information.

## QueueConnectionFactory

A client uses a QueueConnectionFactory to create QueueConnection objects..

See Section 4.2, "Administered Objects" for more information about JMS ConnectionFactory objects.

## QueueConnection

A QueueConnection is an active connection to a JMS PTP provider. A client uses a QueueConnection to create one or more QueueSession objects for producing and consuming messages.

See Section 4.2 "Administered objects" for more information.

## QueueSession

A QueueSession provides methods for creating QueueReceiver, QueueSender, QueueBrowser and TemporaryQueue objects.

If there are messages that have been received but not acknowledged when a QueueSession terminates, these messages must be retained and redelivered when a consumer next accesses the queue.

See Section 4.3 "Connection" for more information.

## QueueReceiver

A client uses a QueueReceiver for receiving messages that have been delivered to a queue.

Although is possible to have two sessions with a QueueReceiver for the same queue, JMS does not define how messages are distributed between the queue receivers.

If a QueueReceiver specifies a message selector, the messages that are not selected remain on the queue. By definition, a message selector allows a QueueReceiver to skip messages. This means that when the skipped messages are eventually read, the total ordering of the reads does not retain the partial order defined by each message producer. Only queue receivers without a message selector will read messages in message producer order.

For more information see Section 4.5 "MessageConsumer". If a MessageConsumer is consuming messages from a queue, then it behaves as described here in Section 5.8 "QueueReceiver".

A client uses a MessageProducer or QueueSender to send messages to a queue.

For more information, see Section 4.6 "MessageProducer".

## QueueBrowser

A client uses a QueueBrowserto look at messages on a queue without removing them. A QueueBrowsercan be created from a Sessionor a QueueSession.

The browse methods return a java.util.Enumerationthat is used to scan the queue’s messages. It may be an enumeration of the entire content of a queue, or it may contain only the messages matching a message selector.

Messages may be arriving and expiring while the scan is done. JMS does not require the content of an enumeration to be a static snapshot of queue content. Whether these changes are visible or not depends on the JMS provider.

A message must not be returned by a QueueBrowser before its delivery time has been reached.

## QueueRequestor

JMS provides a QueueRequestor helper class to simplify making service requests.

The QueueRequestor constructor is given a QueueSession and a destination queue. It creates a TemporaryQueue for the responses and provides a request method that sends the request message and waits for its reply.

This is a basic request/reply abstraction that should be sufficient for most uses. JMS providers and clients can create more sophisticated versions.

## Reliability

A queue is typically created by an administrator and exists for a long time. It is always available to hold messages sent to it, whether or not the client that consumes its messages is active. For this reason, a client does not have to take any special precautions to ensure it does not miss messages.

# JMS publish/subscribe model

## Overview

The JMS Pub/Sub model defines how JMS clients publish messages to, and subscribe to messages from, a well-known node in a content-based hierarchy. JMS calls these nodes *topics*.

In this section, the terms *publish* and *subscribe* are used in place of the more generic terms *produce* and *consume* used previously.

A topic can be thought of as a mini message broker that gathers and distributes messages addressed to it. By relying on the topic as an intermediary, message publishers are kept independent of subscribers and vice versa. The topic automatically adapts as both publishers and subscribers come and go.

Publishers and subscribers are *active* when the Java objects that represent them exist. JMS also supports the optional *durability* of subscribers that ‘remembers’ the existence of them while they are inactive.

This chapter describes the semantics of the Publish/Subscribe model. A JMS provider that supports the Publish/Subscribe model must deliver the semantics described here.

Whether a JMS client program uses the Pub/Sub domain-specific interfaces, or the common interfaces that are described in Chapter 4 "JMS common facilities", the client program *must* be guaranteed the same behavior.

Table 6.1shows the interfaces that are specific to the PTP domain and the JMS common interfaces. The common interfaces are preferred for creating JMS application programs, because they are domain-independent.

Table 6.1 Pub/sub domain interfaces and JMS common interfaces

|  |  |
| --- | --- |
| PTP domain interfaces | JMS common interfaces  *Preferred* |
| TopicConnectionFactory | ConnectionFactory |
| TopicConnection | Connection |
| Topic | Destination |
| TopicSession | Session |
| TopicPublisher | MessageProducer |
| TopicSubscriber | MessageConsumer |

## Pub/sub latency

Since there is typically some latency in all pub/sub systems, the exact messages seen by a subscriber may vary depending on how quickly a JMS provider propagates the existence of a new subscriber and the length of time a provider retains messages in transit.

For instance, some messages from a distant publisher may be missed because it may take a second for the existence of a new subscriber to be propagated system wide. When a new subscriber is created, it may receive messages sent earlier because a provider may still have them available.

JMS does not define the exact semantics that apply during the interval when a pub/sub provider is adjusting to a new client. JMS semantics only apply once the provider has reached a ‘steady state’ with respect to a new client.

## Durable subscription

Nondurable subscriptions last for the lifetime of their subscriber object. This means that a client will only see the messages published on a topic while its subscriber is active. If the subscriber is not active, it is missing messages published on its topic.

At the cost of higher overhead, a subscriber can be made durable. A durable subscriber *registers* a durable subscription with a unique identity that is retained by JMS. Subsequent subscriber objects with the same identity resume the subscription in the state it was left by the prior subscriber. If there is no active subscriber for a durable subscription, JMS retains the subscription’s messages until they are received by the subscription or until they expire.

All JMS providers must be able to run JMS applications that dynamically create and delete durable subscriptions. Some JMS providers may, in addition, provide facilities to administratively configure durable subscriptions. If a durable subscription has been administratively configured, it is valid for it to silently override the subscription specified by the client.

An inactive durable subscription is one that exists but does not currently have a message consumer subscribed to it.

See also section 6.11.3 "Durable subscriptions".

## Topic management

Some products require that topics be statically defined with associated authorization control lists, and so on; others don’t even have the concept of topic administration.

JMS does not define facilities for creating, administering, or deleting topics.

A special type of topic called a TemporaryTopic is provided for creating a *Topic* that is unique to a *TopicConnection*. See Section 6.6 "TemporaryTopic" for more details.

## Topic

A *Topic* object encapsulates a provider-specific topic name. It is the way a client specifies the identity of a topic to JMS methods.

Many Pub/Sub providers group topics into hierarchies and provide various options for subscribing to parts of the hierarchy. JMS places no restriction on what a Topic object represents. It might be a leaf in a topic hierarchy or it might be a larger part of the hierarchy (for subscribing to a general class of information).

The organization of topics and the granularity of subscriptions to them is an important part of a pub/sub application’s architecture. JMS does not specify a policy for how this should be done. If an application takes advantage of a provider-specific topic grouping mechanism, it should document this. If the application is installed using a different provider, it is the job of the administrator to construct an equivalent topic architecture and create equivalent Topic objects.

## TemporaryTopic

A TemporaryTopic is a unique Topic object created for the duration of a Connection or TopicConnection. It is a system defined Topic that can only be consumed only by the Connection or TopicConnection that created it.

By definition, it does not make sense to create a durable subscription to a temporary topic. To do this is a programming error that may or may not be detected by a JMS Provider.

See Section 4.4.3 "Creating temporary destinations" for more information.

## TopicConnectionFactory

A client uses a TopicConnectionFactory to create TopicConnection objects.

See Section 4.2 "Administered objects" for more information about JMS ConnectionFactory objects.

## TopicConnection

A TopicConnection is an active connection to a JMS Pub/Sub provider. A client uses a TopicConnection to create one or more TopicSessionobjects for producing and consuming messages.

See Section 4.3 "Connection" for more information.

## TopicSession

A TopicSession provides methods for creating TopicPublisher, TopicSubscriber and TemporaryTopic objects. It also provides the unsubscribe method for deleting its client’s durable subscriptions.

If there are messages that have been received but not acknowledged when a TopicSessionterminates, a durable TopicSubscribermust retain and redeliver them; a nondurable subscriber need not do so.

See Section 4.4 "Session" for more information.

## TopicPublisher

A client uses a TopicPublisher for publishing messages on a topic. TopicPublisher is the Pub/Sub variant of a JMS MessageProducer. Messages can also be sent to a topicusing a MessageProducer*.* See Section 4.6 "MessageProducer" for a description of its common features.

## TopicSubscriber

A client consumes messages from a topic by creating a subscription on that topic, and creating a MessageConsumer or TopicSubscriber on that subscription.

In general, a subscription will receive a copy of every message sent to the topic. However if a message selector is specified then only those messages whose properties match the message selector will be added to the subscription.

In addition, the noLocal flag may be specified when a MessageConsumer or TopicSubscriber is created. The effect of setting this flag depends on the type of subscription and is defined in the following sections.

Each copy of the message is treated as a completely separate message. Work done on one copy has no effect on any other; acknowledging one does not acknowledge any other; one message may be delivered immediately, while another waits for its consumer to process messages ahead of it.

Subscriptions may be *durable* or *non-durable*.

A *non-durable subscription* exists only so long as a MessageConsumer or TopicSubscriber object exists to consume messages from it. A non-durable subscription may be either *unshared* or *shared*.

An *unshared non-durable subscription* does not have a name and may have only a single MessageConsumer or TopicSubscriber object associated with it. It is created automatically when the MessageConsumer or TopicSubscriber object is created. It is not persisted and is deleted automatically when it is closed. See section 6.11.1 "Unshared non-durable subscriptions" below.

A *shared non-durable subscription* is identified by name and an optional client identifier, which may be used to associate several MessageConsumer or TopicSubscriber objects with it. It is created automatically when the first MessageConsumer or TopicSubscriber object is created. It is not persisted and is deleted automatically when the last MessageConsumer or TopicSubscriber object is closed. See section 6.11.2 "Shared non-durable subscriptions" below.

A *durable subscription* is identified by a name and an optional client identifier, which may be used to associate several MessageConsumer or TopicSubscriber objects with it. A durable subscription is created automatically when the first MessageConsumer or TopicSubscriber object is created. It is persisted and continues to exist until explicitly deleted, even if there are no MessageConsumer or TopicSubscriber objects consuming messages from it. See section 6.11.3 "Durable subscriptions" below.

### Unshared non-durable subscriptions

An unshared non-durable subscription is the simplest way to consume messages from a topic.

An unshared non-durable subscription is created, and a MessageConsumer created on that subscription, using one of the createConsumer methods on Session, JMSContext or TopicSession.

Alternatively an unshared non-durable subscription is created, and a TopicSubscription created on that subscription, using one of the createSubscriber methods on TopicSession.

An unshared non-durable subscription does not have a name. Each call to createConsumer or createSubscriber creates a new subscription.

An unshared non-durable subscription only exists for as long as the MessageConsumer or TopicSubscriber exists. This means that any messages sent to the topic will only be added to the subscription whilst the MessageConsumer or TopicSubscriber is active. The subscription is not persisted and will be deleted (together with any undelivered messages associated with it) when the consumer is closed.

If a message selector is specified then only messages with properties matching the message selector expression will be added to the subscription.

The noLocal argument may be used to specify that messages published to the topic by its own connection must not be added to the subscription.

Each unshared non-durable subscription has a single consumer. If the application needs to create multiple consumers on the same subscription then a shared non-durable subscription should be used instead. See section 6.11.2 "Shared non-durable subscriptions".

If the application needs to be able to receive messages that were sent to the topic even when there was no active consumer on it then a durable subscription should be used instead. See section 6.11.3 "Durable subscriptions".

### Shared non-durable subscriptions

A non-durable shared subscription is used by a client that needs to be able to share the work of receiving messages from a topic subscription amongst multiple consumers. A non-durable shared subscription may therefore have more than one consumer. Each message from the subscription will be delivered to only one of the consumers on that subscription.

A shared non-durable subscription is created, and a MessageConsumer created on that subscription, using one of the createSharedConsumer methods on Session, TopicSession or JMSContext. The same methods may be used to create a MessageConsumer on an existing shared non-durable subscription.

A shared non-durable subscription is identified by a name specified by the client and by the client identifier if set. If the client identifier was set when the shared non-durable subscription was first created then a client which subsequently wishes to create a consumer on that shared non-durable subscription must use the same client identifier.

A shared non-durable subscription only exists for as long as a MessageConsumer or TopicSubscriber exists on the subscription. This means that any messages sent to the topic will only be added to the subscription whilst a MessageConsumer or TopicSubscriber is active. The subscription is not persisted and will be deleted (together with any undelivered messages associated with it) when the last consumer on the subscription is closed.

If a message selector is specified then only messages with properties matching the message selector expression will be added to the subscription.

When the application calls one of the above methods to create a shared non-durable subscription is on a topic, the noLocal argument may be used to specify that messages published to the topic by the Session, TopicSession or JMSContext 's own connection, or any other connection with the same client identifier, will not be added to the shared non-durable subscription. If the client identifier is unset then setting noLocal to true will cause an IllegalStateException or IllegalStateRuntimeException (depending on the method signature) to be thrown.

If there is an active consumer on the shared non-durable subscription (or a consumed message from that subscription is still part of a pending transaction or is not yet acknowledged in the session), and an attempt is made to create an additional consumer, specifying the same name and client identifier (if set) but a different topic or message selector, or, if the client identifier is set, a different noLocal value, then a JMSException or JMSRuntimeException will be thrown.

There is no restriction to prevent a shared non-durable subscription and a durable subscription having the same name. Such subscriptions would be completely separate.

See also section 4.3.2 "Client identifier".

### Durable subscriptions

A durable subscription is used by a client that needs to receive all the messages published on a topic, including the ones published when there is no consumer associated with it. The JMS provider retains a record of this durable subscription and ensures that all messages from the topic's publishers are retained until they are delivered to, and acknowledged by, a consumer on the durable subscription or until they have expired.

A durable subscription is created, and a MessageConsumer created on that subscription, using one of the createDurableConsumer methods on Session, TopicSession or JMSContext. The same methods may be used to create a MessageConsumer on an existing durable subscription.

Session and TopicSession also have createDurableSubscriber methods which have the same behavior as createDurableConsumer but which return a TopicSubscriber.

A durable subscription which has a consumer associated with it is described as being active. A durable subscription which has no consumer associated with it is described as being inactive.

A durable subscription may have more than one active consumer (this was not permitted prior to JMS 2.0). Each message from the subscription will be delivered to only one of the consumers on that subscription.

A durable subscription is identified by a name specified by the client and by the client identifier if set. If the client identifier was set when the durable subscription was first created then a client which subsequently wishes to create a consumer on that durable subscription must use the same client identifier.

A durable subscription will continue to accumulate messages until it is deleted using the unsubscribe method on the Session, TopicSession or JMSContext. This deletes the state being maintained on behalf of the subscriber by its provider. It is erroneous for a client to delete a durable subscription while it has an active consumeror while a message received from it is part of a current transaction or has not been acknowledged in the session.

If a message selector is specified then only messages with properties matching the message selector expression will be added to the subscription.

When the application calls one of the above methods to create a durable subscription is created on a topic, the noLocal argument may be used to specify that messages published to the topic by the Session, TopicSession or JMSContext's own connection, or any other connection with the same client identifier, will not be added to the durable subscription. If the client identifier is unset then setting noLocal to true will cause an IllegalStateException or IllegalStateRuntimeException (depending on the method signature) to be thrown.

If there are no active consumers on the durable subscription (and no consumed messages from that subscription are still part of a pending transaction or are not yet acknowledged in the session), and this method is used to create a new consumer on that durable subscription, specifying the same name and client identifier (if set) but a different topic or message selector, or, if the client identifier is set, a different noLocal value, then the durable subscription will be deleted and a new one created.

However if there is an active consumer on the durable subscription (or a consumed message from that subscription is still part of a pending transaction or is not yet acknowledged in the session), and an attempt is made to create an additional consumer, specifying the same name and client identifier (if set) but a different topic or message selector, or, if the client identifier is set, a different noLocal value, then a JMSException or JMSRuntimeException will be thrown.

There is no restriction to prevent a durable subscription and a shared non-durable subscription having the same name. Such subscriptions would be completely separate.

See also section 6.3 "Durable subscription" and section 4.3.2 "Client identifier".

## Recovery and redelivery

Unacknowledged messages of a nondurable subscriber should be able to be recovered for the lifetime of that nondurable subscriber. When a nondurable subscriber terminates, messages waiting for it will likely be dropped whether or not they have been acknowledged.

Only durable subscriptions are reliably able to recover unacknowledged messages.

Sending a message to a topic with a delivery mode of PERSISTENT does not alter this model of recovery and redelivery. To ensure delivery, a TopicSubscribershould establish a durable subscription.

## Administering subscriptions

Ideally, publishers and subscribers are dynamically registered by a provider when they are created. From the client viewpoint this is always the case. From the administrator’s viewpoint, other tasks may be needed to support the creation of publishers and subscribers.

The amount of resources allocated for message storage and the consequences of resource overflow are not defined by JMS.

## TopicRequestor

JMS provides a TopicRequestor helper class to simplify making service requests.

The TopicRequestor constructor is given a TopicSession and a destination topic. It creates a TemporaryTopic for the responses and provides a request method that sends the request message and waits for its reply.

This is a basic request/reply abstraction that should be sufficient for most uses. JMS providers and clients are free to create more sophisticated versions.

## Reliability

When all messages for a topic must be received, a durable subscriber should be used. JMS insures that messages published while a durable subscriber is inactive are retained by JMS and delivered when the subscriber subsequently becomes active.

Non-durable subscribers should only be used when missed messages are tolerable.

Table 6.2 Pub/sub reliability

|  |  |  |
| --- | --- | --- |
| How Published | Non-Durable Subscriber | Durable Subscriber |
| NON\_PERSISTENT | at-most-once  (missed if inactive) | at-most-once |
| PERSISTENT | once-and-only-once  (missed if inactive) | once-and-only-once |

# JMS exceptions

## Overview

This chapter provides an overview of JMS exception handling and defines the standard JMS exceptions.

## The JMSException

JMS defines JMSException as the root class for exceptions thrown by JMS methods. JMSException is a checked exception and catching it provides a generic way of handling all JMS related exceptions. JMSException provides the following information:

* A provider-specific string describing the error - This string is the standard Java exception message, and is available via getMessage().
* A provider-specific string error code
* A reference to another exception - Often a JMS exception will be the result of a lower level problem. If appropriate, this lower level exception can be linked to the JMS exception.

JMS methods only include JMSException in their signatures. JMS methods can throw any JMS standard exception as well as any JMS provider specific exception. **The javadoc for JMS methods documents only the mandatory exception cases.**

## Standard exceptions

In addition to JMSException, JMS defines several additional exceptions that standardize the reporting of basic error conditions.

There are only a few cases where JMS mandates that a specific JMS exception must be thrown. These cases are indicated by the words **must be** in the exception description. **These cases are the only ones on which client logic** should depend on a specific problem resulting in a specific JMS exception being thrown.

In the remainder of cases, it is strongly suggested that JMS providers use one of the standard exceptions where possible. JMS providers may also derive provider-specific exceptions from these if needed.

JMS defines the following standard exceptions:

* IllegalStateException: This exception is thrown when a method is invoked at an illegal or inappropriate time or if the provider is not in an appropriate state for the requested operation. For example, this exception **must be** thrown if Session.commit()is called on a non-transacted session. This exception is also **must be** called when domain inappropriate method is called, such as calling TopicSession.CreateQueueBrowser().
* JMSSecurityException: This exception **must be** thrown when a provider rejects a user name/password submitted by a client. It may also be thrown for any case where a security restriction prevents a method from completing.
* InvalidClientIDException: This exception **must be** thrown when a client attempts to set a connection’s client identifier to a value that is rejected by a provider.
* InvalidDestinationException: This exception **must be** thrown when a destination is either not understood by a provider or is no longer valid.
* InvalidSelectorException: This exception **must be** thrown when a JMS client attempts to give a provider a message selector with invalid syntax.
* MessageEOFException: This exception **must be** thrown when an unexpected end of stream has been reached when a StreamMessageor BytesMessageis being read.
* MessageFormatException: This exception **must be** thrown when a JMS client attempts to use a data type not supported by a message or attempts to read data in a message as the wrong type. It must also be thrown when equivalent type errors are made with message property values. For example, this exception **must be** thrown if StreamMessage.writeObject()is given an unsupported class or if StreamMessage.readShort()is used to read a boolean value. This exception also **must be** thrown if a provider is given a type of message it cannot accept. Note that the special case of a failure caused by attempting to read improperly formatted Stringdata as numeric values must throw the java.lang.NumberFormatException.
* MessageNotReadableException: This exception **must be** thrown when a JMS client attempts to read a write-only message.
* MessageNotWriteableException: This exception **must be** thrown when a JMS client attempts to write to a read-only message.
* ResourceAllocationException: This exception is thrown when a provider is unable to allocate the resources required by a method. For example, this exception should be thrown when a call to *createTopicConnection* fails due to lack of JMS provider resources.
* TransactionInProgressException: This exception is thrown when an operation is invalid because a transaction is in progress. For instance, attempting to call Session.commit()when a session is part of a distributed transaction should throw a TransactionInProgressException*.*
* TransactionRolledBackException: This exception **must be** thrown when a call to Session.commit()results in a rollback of the current transaction.

# JMS application server facilities

## Overview

This chapter describes JMS facilities for concurrent processing of a subscription’s messages. It also defines how a JMS provider supplies JTS aware sessions. These facilities are primarily intended for the use of the JMS provider.

If JMS clients use the JTS aware facilitiest client program may be non-portable code, because JMS providers are not required to support these interfaces.

The facilities described in this chapter are a special category of JMS. They are optional and might only be supported by some JMS providers.

## Concurrent processing of a subscription’s messages

JMS provides a special facility for creating a MessageConsumer that can concurrently consume messages.

This facility partitions the work into three roles:

* JMS provider - its role is to deliver the messages.
* Application Server - its role is to create the consumer and manage the threads used by the concurrent MessageListener objects.
* Application - its role is to define a subscription with a destination and optionally a message selector and provide a single threaded MessageListener class to consume its messages. An application server will construct multiple objects of this class to concurrently consume messages.

### Session

Sessions provide the following methods for use by application servers:

* setMessageListener() and getMessageListener() - a session’s MessageListener consumes messages that have been assigned to the session by a ConnectionConsumer, as described in the next few paragraphs.
* run() - causes the messages assigned to its session by a ConnectionConsumer to be serially processed by the session’s MessageListener. When the listener returns from processing the last message, run() returns.

An application server would typically be given a MessageListener class that contained the single threaded code written by an application programmer to process messages. It would also be given the destination and message selector that specified the messages the listener was to consume.

An application server would take care of creating the JMS Connection, ConnectionConsumer, and Session objects it needs to handle message processing. It would create as many MessageListener instances as it needed and register each with its own session.

Since many listeners will need to use the services of its session, the listener is likely to require that its session be passed to it as a constructor parameter.

### ServerSession

A ServerSession is an object implemented by an application server. It is used by an application server to associate a thread with a JMS session.

A ServerSession implements two methods:

* getSession() - returns the ServerSession’s JMS Session.
* start() - starts the execution of the ServerSession thread and results in the execution of the associated JMS Session’s run method.

### ServerSessionPool

A ServerSessionPool is an object implemented by an application server to provide a pool of ServerSession objects for processing the messages of a ConnectionConsumer.

Its only method is getServerSession(). This removes a ServerSession from the pool and gives it to the caller (which is assumed to be a ConnectionConsumer) to use for consuming one or more messages.

JMS does not architect how the pool is implemented. It could be a static pool of ServerSession objects or it could use a sophisticated algorithm to dynamically create ServerSession objects as needed.

If the ServerSessionPool is out of ServerSession objects, the getServerSession() method may block. If a ConnectionConsumer is blocked, it cannot deliver new messages until a ServerSession is eventually returned.

### ConnectionConsumer

For application servers, connections provide a special facility for creating a ConnectionConsumer. The messages it is to consume are specified by a destination and a message selector. In addition, a ConnectionConsumer must be given a ServerSessionPool to use for processing its messages. A maxMessages value is specified to limit the number of messages a ConnectionConsumer may load at one time into a ServerSession’s Session.

Normally, when traffic is light, a ConnectionConsumer gets a ServerSession from its pool; loads its Session with a single message; and, starts it. As traffic picks up, messages can back up. If this happens, a ConnectionConsumer can load each Session with more than one message. This reduces the thread context switches and minimizes resource use at the expense of some serialization of a message processing.

### How a ConnectionConsumer uses a ServerSession

A ConnectionConsumer implemented by a JMS provider uses a ServerSession to process one or more messages that have arrived. It does this as follows:

It gets a ServerSession from the its ServerSessionPool

It gets the ServerSession’s Session

It loads the Session with one or more messages

It then starts the ServerSession to consume these messages

A ConnectionConsumer for a QueueConnection will expect to load its messages into a QueueSession, as one for a TopicConnection would expect to load a TopicSession.

Note that JMS does not architect how the ConnectionConsumer loads the Session with messages. Since both the ConnectionConsumer and Session are implemented by the same JMS provider, they can accomplish the load using a private mechanism.

### How an application server implements a ServerSession

JMS does not architect the implementation of a ServerSession. A typical implementation is presented here to illustrate the concept:

An app server creates a Thread for a ServerSession registering the ServerSession’s runObject. The implementation of this runObject is private to the app server.

The ServerSession’s start method calls its Thread’s start method. As with all Java threads, a call to start initiates execution of the started thread and calls the thread’s runObject. The caller to ServerSession.start (the ConnectionConsumer) and the ServerSession runObject are now running in different threads.

The runObject will do some housekeeping and then call its Session’s run() method. On return, the runObject puts its ServerSession back into its ServerSessionPool and returns. This terminates execution of the ServerSession’s thread and the cycle starts again.

### The result

JMS has defined a flexible mechanism that partitions the job of concurrent message consumption into roles that are well suited for each participant.

The application programmer provides a simple to write, single threaded implementation of MessageListener.

The JMS provider retains control of its messages until they are delivered to the MessageListener. This ensures it is under direct control of message acknowledgment.

The application server is in control of setting up the ConnectionConsumer and managing all the threads used for executing its MessageListeners.

The following diagram illustrates the relationship between the three roles and the objects they implement.



The following diagram illustrates the process a ConnectionConsumer uses to deliver a message to a MessageListener*.*



## XAConnectionFactory

Some application servers provide support for grouping resource use into a distributed transaction. To include JMS transactions in a distributed transaction, an application server requires a Java Transaction API (JTA) capable JMS provider. A JMS provider exposes its JTA support using a JMS XAConnectionFactory which an application server uses to create XAConnection objects.

XAConnectionFactory provides the same authentication options as ConnectionFactory.

XAConnectionFactory objects are JMS administered objects just like ConnectionFactory objects. It is expected that application servers will find them using JNDI.

## XAConnection

XAConnection extends the capability of Connection by providing the ability to create XASession objects.

## XASession

XASession provides access to what looks like a normal Session object and a javax.transaction.xa.XAResource object which controls the session’s transaction context. The functionality of XAResource closely resembles that defined by the standard X/Open XA Resource interface.

An application server controls the transactional assignment of an XASession by obtaining its XAResource. It uses the XAResource to assign the session to a distributed transaction; prepare and commit work on the transaction, and so on.

An XAResource provides some fairly sophisticated facilities for interleaving work on multiple transactions, recovering a list of transactions in progress, and so on. A JTA aware JMS provider must fully implement this functionality. This could be done by using the services of a database that supports XA, or a JMS provider may choose to implement this functionality from scratch.

A client of the application server is given the XASession’s Session. Behind the scenes, the application server controls the transaction management of the underlying XASession.

It is important to note that a distributed transaction context does not flow with a message; that is, the receipt of the message cannot be part of the same transaction that produced the message. This is the fundamental difference between messaging and synchronized processing. Message producers and consumers use an alternative approach to reliability that is built upon a JMS provider’s ability to supply a once-and-only-once message delivery guarantee.

To reiterate, the act of producing and/or consuming messages in a Session can be transactional. The act of producing and consuming a specific message across different sessions cannot.

## JMS application server interfaces

Both PTP and Pub/Sub domains provide their own versions of JTS aware JMS facilities.

However, there are common interfaces available, which should be used in preference to the domain-specific interfaces. These are listed as JMS common interfaces in Table 8.1.

Table 8.1 Relationship of optional interfaces in domains

|  |  |  |
| --- | --- | --- |
| JMS common Interfaces | PTP interfaces | Pub/sub interfaces |
| ServerSessionPool | *Not domain-specific* | *Not domain-specific* |
| ServerSession | *Not domain-specific* | *Not domain-specific* |
| ConnectionConsumer | *Not domain-specific* | *Not domain-specific* |
| XAConnectionFactory | XAQueueConnectionFactory | XATopicConnectionFactory |
| XAConnection | XAQueueConnection | XATopicConnection |
| XASession | XAQueueSession | XATopicSession |

# JMS example code

This chapter gives some code examples that show how a JMS client could use the JMS API. It also demonstrates how to use several message types. The examples use methods that support a unified messaging model: these examples work with either Point-to-Point or Publish/Subscribe messaging. This is the recommended approach to working with the JMS API.

In earlier versions of the JMS Specification, only the separate interfaces for each messaging domain (Point-to-Point or Pub/Sub) were supported, and the client was programmed to use one messaging domain or the other. Now, the JMS client can be programmed using the JMS common interfaces.

In the example program, a client application sends and receives stock quote information. The messages the client application receives are from a stock quote service that sends out stock quote messages. The stock quote service is not described in the example.

To simplify the example, no exception-handling code is included.

This chapter describes the steps for creating the correct environment for sending and receiving a message.

After describing these basic functions, this chapter describes how to perform some other common functions, such as using message selectors.

## Preparing to send and receive messages

Here are the basic steps to establish a connection and prepare to send and receive messages.

* Get a ConnectionFactory and Destination
* Create a Connection and Session
* Create a MessageConsumer
* Create a MessageProducer

### Getting a ConnectionFactory

Both the message producer and message consumer (the sender and receiver) need to get a ConnectionFactoryand use it to set up both a Connectionand a Session.

An administrator typically has created and configured a ConnectionFactoryfor the JMS client’s use. The client program typically uses the JNDI API to look up the ConnectionFactory*.*

import javax.naming.\*;

import javax.jms.\*;

ConnectionFactory connectionFactory;

Context messaging = new InitialContext()

connectionFactory = (ConnectionFactory)  
 messaging.lookup("ConnectionFactory");

### Getting a Destination

An administrator has created and configured a Queuenamed “StockSource” which is where stock quote messages are sent and received. Again, the destination can be looked up using the JNDI API.

Queue stockQueue;

stockQueue = (Queue)messaging.lookup("StockSource");

### Creating a Connection

Having obtained the ConnectionFactory, the client program uses it to create a Connection.

Connection connection;

connection = connectionFactory.createConnection();

A Connection must be closed after use. This may be done explicitly using the close method:

connection.close();

Alternatively a connection may be closed automatically using the try-with-resources statement:

try (Connection connection =

connectionFactory.createConnection();){

// use connection in this try block

// it will be closed when try block completes

} catch (JMSException e){

// exception handling

}

### Creating a Session

Having obtained the Connection, the client program uses it to create a Session. The Sessionis used to create a MessageProducer(to send messages) or a MessageConsumer(to receive messages).

There are three createSession methods on Connection, with different numbers of arguments. Java SE applicatrions such as this example should use the method with one integer argument, sessionMode. This single argument indicates

* whether the session will use a local transaction or whether it is non-transacted and,
* if the session is non-transacted, what mode whould be used for acknowledging the receipt of messages.

Session session;

/\* Session is not transacted,

\* uses AUTO\_ACKNOWLEDGE for message acknowledgement

\*/

session = connection.createSession(

Session.AUTO\_ACKNOWLEDGE);

### Creating a MessageProducer

Having obtained the Session, the client program uses the Sessionto create a MessageProducer. The MessageProducerobject is used to send messages to the destination. The MessageProduceris created by using the Session.createProducermethod, supplying as a parameter the destination to which the messages are sent.

MessageProducer sender;

/\* Value in stockQueue previously looked up in the JNDI

\* createProducer takes a Destination

\*/

sender = session.createProducer(stockQueue);

### Creating a MessageConsumer

Messages can be consumed either synchronously or asynchronously. This example shows how to create a message consumer that consumes messages synchronously. See section 9.3.1 "Receiving messages asynchronously" to learn more about consuming messages asynchronously.

A MessageConsumeris used to receive messages from the destination, which in this example is the QueuestockQueue. A MessageConsumeris created using the Session.createConsumermethod, supplying one parameter, the destination from which messages are received.

MessageConsumer receiver;

/\* Value in stockQueue previously looked up in the JNDI

\* createConsumer takes a Destination

\*/

receiver = session.createConsumer(stockQueue);

### Starting message delivery

Up until this point, delivery of messages has been inhibited so that the preceding setup could be done without being interrupted with asynchronously delivered messages. Now that the setup is complete, the Connectionis told to begin the delivery of messages to its MessageConsumer.

connection.start();

### Using a TextMessage

There are several JMS Messageformats. For this example, the stock quote information is sent as a text string that is read and displayed by the client.

The following demonstrates how to create such a message:

String stockData; /\* Stock information as a string \*/

TextMessage message;

/\* Set the message’s text to be the stockData string \*/

message = session.createTextMessage();

message.setText(stockData);

## Sending and receiving messages

Now that the setup of the Sessionis complete, you can send and receive messages. This section describes how to:

* Create a message
* Send a message
* Receive a message synchronously

### Sending a message

To send a message, use the MessageProducer.sendmethod, supplying a Messageobject for the method’s parameter.

/\* Send the message \*/

sender.send(message);

### Receiving a message synchronously

To receive the next message in the queue, you can use the MessageConsumer.receivemethod. This call blocks indefinitely until a message arrives on the queue. The same method can be used to receive from a topic.

TextMessage stockMessage;

stockMessage = (TextMessage)receiver.receive();

To limit the amount of time that the client blocks, use a timeout parameter with the receivemethod. If no messages arrive by the end of the timeout, then the receivemethod returns. The timeout parameter is expressed in milliseconds.

TextMessage stockMessage;

/\* Wait 4 seconds for a message \*/

TextMessage = (TextMessage)receiver.receive(4000);

### Unpacking a TextMessage

The stock quote information is sent using a TextMessage*.* To get the information from the message, use the TextMessage.getTextmethod. It returns the message content as a string.

/\* Stock information as a string \*/

String newStockData;

newStockData = message.getText();

## Other messaging features

This section goes beyond basic messaging functions, and describes how to perform some other common messaging functions:

* Create an asynchronous MessageListener
* Use a message selector to filter message delivery
* Create a durable subscription to a topic
* Re-connect to a topic using a durable subscription

### Receiving messages asynchronously

In order to receive message asynchronously as they are delivered to the message consumer, the client program needs to create a message listener that implements the MessageListenerinterface. An implementation of the MessageListenerinterface, called StockListener.java*,* might look like this:

import javax.jms.\*;

public class StockListener implements MessageListener

{

public void onMessage(Message message) {

/\* Unpack and handle the messages received \*/

...

}

}

The client program registers the MessageListenerobject with the MessageConsumerobject in the following way:

StockListener myListener = new StockListener();  
  
/\* Receiver is MessageConsumer object \*/  
receiver.setMessageListener(myListener);

The Connectionmust be started for the message delivery to begin. The MessageListeneris asynchronously notified whenever a message has been published to the queue. This is done via the onMessagemethod in the MessageListenerinterface. It is up to the client to process the message there.

public void onMessage(Message message)

{

String newStockData;

/\* Unpack and handle the messages received \*/

newStockData = message.getText();

if(...)

{

/\* Logic related to the data \*/

}

}

### Using message selection

A client program may be interested in receiving only certain stock quotes. A message selector can be used to achieve this goal. Message selectors work against properties that are assigned to the message.

In this example, the client program is only interested in technology related stocks. The sender of the messages assigns a value to a message property called StockSector. The values the sender assigns include "Technology", "Financial", "Manufacturing", "Emerging", and "Global". The message sender assigns these property values by using the Message.setStringPropertymethod.

String stockData; /\* Stock information as a String \*/

TextMessage message;

/\* Set the message’s text to be the stockData string \*/

message = session.createTextMessage();

message.setText(stockData);

/\* Set the message property ‘StockSector’ \*/

message.setStringProperty("StockSector", "Technology");

When the client program that receives the stock quote messages creates MessageConsumeris created, the client program can create a message selector string to determine which messages it will receive.

String selector;

selector = new String("(StockSector = ’Technology’)");

This string is specified when the MessageConsumeris created:

MessageConsumer receiver;

receiver = session.createConsumer(stockQueue,selector);

The client program receives only messages related to the technology sector.

### Using durable subscriptions

Durable subscriptions are used to receive messages from a topic. When a JMS client creates a durable subscription, the client can later disconnect from the topic. When the client program re-connects, it can receive the messages that arrived while it was disconnected. In this example, the topicprovides information about news updates.

#### Creating a durable subscription

The following example sets up durable subscription that gets messages from a topic. First, the client program must perform the usual setup steps of looking up ConnectionFactoryand a Destination, and creating a Connectionand Session, as described in section 9.1 "Preparing to send and receive messages".

import javax.naming.\*;

import javax.jms.\*;

/\* Look up connection factory \*/

ConnectionFactory connectionFactory;

Context messaging = new InitialContext();

connectionFactory =

(ConnectionFactory)

Messaging.lookup("ConnectionFactory")

/\* Look up destination \*/

Topic newsFeedTopic;

newsFeedTopic = messaging.lookup("BreakingNews");

/\* Create connection and session \*/

Connection connection;

Session session;

connection = ConnectionFactory.createConnection();

session = connection.createSession(

Session.AUTO\_ACKNOWLEDGE);

Having performed the normal setup, the client program can now create a durable subscriber to the destination. To do this, the client program creates a durable TopicSubscriber, using session.CreateDurableSubscriber*.* The name "mySubscription"is used as an identifier of the durable subscription.

session.createDurableSubscriber(newsFeedTopic,

"mySubscription");

At this point, the client program can start the connection and start to receive messages.

#### Creating a consumer on an existing durable subscription

Once a durable subscription has been created it will continue to accumulate messages until the subscription is deleted using the Session method unsubscribe, even if the original consumer is closed leaving no consumer on the durable subscription.

A client application may create a consumer on an existing durable subscription by calling one of the Session methods createDurableConsumer or createDurableSubscriber, supplying the same parameters that were specified when the durable subscription was first created.

/\* Create a consumer on an existing durable subscription \*/

session.createDurableConsumer(newsFeedTopic, "mySubscription");

If there were no consumers on the durable subscription prior to calling this method then any messages which were added to the subscription whilst it had no consumers will be delivered.

A durable subscription may have more than one active consumer (this was not permitted prior to JMS 2.0). Each message from the subscription will be delivered to only one of the consumers on that subscription.

When creating a consumer on an existing durable subscription there are some important restrictions to be aware of:

* The Destinationand subscription name must be the same as when the durable subscription was first created.
* If the connection's client identifier was set when the durable subscription was first created then the same client identifier must be set when subsequently creating a consumer on it.
* If a message selector was specified when the durable subscription was first created then the same message selector must be specified when subsequently creating a consumer on it.

## JMS message types

There are five JMS message types. This section provides an example of how to create and unpack each of these types. In each example, the data sent in the message is stock-quote-related data. In all cases, the code that creates the actual content of the messages is omitted.

### Creating a TextMessage

In this example, the stock quote information is sent as a TextMessage*.* A TextMessagecarries the message as a text string that can be read by the client.

The following code demonstrates how to create such a message:

String stockData; /\* Stock information as a string \*/

TextMessage message;

message = session.createTextMessage();

/\* Set the stockData string to the message body \*/

message.setText(stockData);

### Unpacking a TextMessage

To unpack a TextMessage*,* the client uses the Message.getTextmethod.

String stockInfo; /\* String to hold stock info \*/

stockInfo = message.getText();

### Creating a BytesMessage

The stock quote information could be in a binary format that the server knows how to construct and that the client program knows how to interpret and display as a stock quote. This is sent as a BytesMessage.

Such a message can be constructed in the following way:

/\* Stock information as a byte array \*/

byte[] stockData; BytesMessage message;

message = session.createBytesMessage();

message.writeBytes(stockData);

### Unpacking a BytesMessage

When the BytesMessageis received, it can be unpacked in the following manner:

/\* Byte array to hold stock information \*/

byte[] stockData;

int length;

length = message.readBytes(stockData);

The message body is copied to the byte array. The client program can then begin reading and interpreting the data.

### Creating a MapMessage

Each stock message sent by the server could be a map of various stock quote name/value pairs, using a MapMessage. For example, it could contain entries for:

* Stock quote name - represented as a String
* Current value - represented as a double
* Time of quote - represented as a long
* Last change - represented as a double
* Stock information - represented as a String

To construct the MapMessage, the client program uses the various set methods (setString, setLong, and so forth) that are associated with MapMessage, and sets each named value in the MapMessage.

String stockName; /\* Name of the stock \*/

double stockValue; /\* Current value of the stock \*/

long stockTime; /\* Time stock quote was updated \*/

double stockDiff; /\* +/- change in the stock quote\*/

String stockInfo; /\* Information on this stock \*/

MapMessage message;

message = session.createMapMessage();

Note that the following can be set in any order.

/\* First parameter is the name of the map element,

\* second is the value

\*/

message.setString("Name", "SUNW");

message.setDouble("Value", stockValue);

message.setLong("Time", stockTime);

message.setDouble("Diff", stockDiff);

message.setString("Info",

"Recent server announcement causes market interest");

### Unpacking a MapMessage

To unpack the MapMessage, the client program uses the various get methods associated with MapMessageto get the values in the named MapMessageelements. In the following example, the client program expects certain MapMessageelements.

String stockName; /\* Name of the stock \*/

double stockValue; /\* Current value of the stock \*/

long stockTime; /\* Time stock quote was updated \*/

double stockDiff; /\* +/- change in the stock \*/

String stockInfo; /\* Information on this stock \*/

The data is retrieved from the message by using a get method and providing the name of the value desired. The elements from the MapMessagecan be obtained in any order.

stockName = message.getString("Name");

stockDiff = message.getDouble("Diff");

stockValue = message.getDouble("Value");

stockTime = message.getLong("Time");

If a client program needs to get a list of the elements in a MapMessage, it can use the method MapMessage.getMapNames.

### Creating a StreamMessage

In a similar fashion to the MapMessage, an application could send a message consisting of various fields written in sequence to the message, each in their own primitive type. To do this, it would use a StreamMessage. Here’s the primitive types assigned to each item in the stock quote message.

* Stock quote name - String
* Current value - double
* Time of quote - long
* Last change - double
* Stock information - String

The client program might be interested in only some of the message fields, but in the case of a StreamMessage, the client has to read and potentially discard each field in turn.

In the following example, the values for each of the following has already been set:

String stockName; /\* Name of the stock \*/

double stockValue; /\* Current value of the stock \*/

long stockTime; /\* Time stock quote was updated \*/

double stockDiff; /\* +/- change in the stock quote \*/

String stockInfo; /\* Information on this stock\*/

StreamMessage message;

/\* Create message \*/

message = session.createStreamMessage();

The following elements have to be written to the StreamMessagein the order they will be read. Notice that they are not separately named properties, as in MapMessage*.*

/\* Set data for message \*/  
message.writeString(stockName);  
message.writeDouble(stockValue);  
message.writeLong(stockTime);  
message.writeDouble(stockDiff);  
message.writeString(stockInfo);

### Unpacking a StreamMessage

The elements of a StreamMessagehave to be read in the order they were written.

String stockName; /\* Name of the stock quote \*/

double stockValue; /\* Current value of the stock \*/

long stockTime; /\* Time stock quote was updated \*/

double stockDiff; /\* +/- change in the stock quote \*/

String stockInfo; /\* Information on this stock \*/

stockName = message.readString();

stockValue = message.readDouble();

stockTime = message.readLong();

stockDiff = message.readDouble();

stockInfo = message.readString();

### Creating an ObjectMessage

The stock information could be sent in the form of a special StockObjectJava object. This object can then be sent as the body of a ObjectMessage. The ObjectMessagecan be used to send Java objects.

These values are set using methods that are unique to the StockObjectimplementation. For example, StockObject may have methods that set the various data values. An application using StockObject might look like this:

String stockName; /\* Name of the stock quote \*/

double stockValue; /\* Current value of the stock \*/

long stockTime; /\* Time stock quote was updated \*/

double stockDiff; /\* +/- change in the stock quote \*/

String stockInfo; /\* Information on this stock \*/

/\* Create a StockObject \*/

StockObject stockObject = new StockObject();

/\* Establish the values for the StockObject \*/

stockObject.setName(stockName);

stockObject.setValue(stockValue);

stockObject.setTime(stockTime);

stockObject.setDiff(stockDiff);

stockObject.setInfo(stockInfo);

To create an ObjectMessage, to pass the StockObjectin the message, you would do the following:

/\* Create an ObjectMessage \*/  
ObjectMessage message;  
message = session.createObjectMessage();  
  
/\* Set the body of the message to the StockObject \*/

message.setObject(stockObject);

### Unpacking an ObjectMessage

To unpack an ObjectMessage, use the ObjectMessage.getObjectmethod to get the object. Once the object is retrieved, the client program can use methods appropriate to that object type to retrieve data from the object.

StockObject stockObject;

/\* Retrieve the StockObject from the message \*/

stockObject = (StockObject)message.getObject();

/\* Extract data from the StockObject by using  
 StockObject methods \*/

String stockName; /\* Name of the stock quote \*/

double stockValue; /\* Current value of the stock \*/

long stockTime; /\* Time stock quote was updated \*/

double stockDiff; /\* +/- change in the stock quote \*/

String stockInfo; /\* Information on this stock \*/

stockName = stockObject.getName();

stockValue = stockObject.getValue();

stockTime = stockObject.getTime();

stockDiff = stockObject.getDiff();

stockInfo = stockObject.getInfo();

# Use of JMS API in Java EE applications

## Overview

The Java™ Platform, Enterprise Edition (Java EE) Specification, v7 requires support for the JMS API as part of the full Java EE platform.

The Java EE platform provides a number of additional features which are not available in the Java Platform Standard Edition (Java SE). These include the following:

* Support for distributed transactions which are demarcated either programmatically, using methods on javax.transaction.UserTransaction, or automatically by the container. These are referred to in this specification as JTA transactions to distinguish them from JMS local transactions.
* Support for JMS message-driven beans.

These features are defined in detail in other specifications including the Java EE 7 specification and the Enterprise JavaBeans 3.2 specification. However the use of the Java EE platform imposes restrictions on the way that the JMS API may be used by applications, and those restrictions are described here.

The JMS specification does not define how a Java EE container integrates with its JMS provider. Different Java EE containers may integrate with their JMS provider in different ways.

## Restrictions on the use of JMS API in the Java EE web or EJB container

JMS applications which run in the Java EE web or EJB container are subject to a number of restrictions in the way the JMS API may be used. These restrictions are necessary for the following reasons:

* In a Java EE web or EJB container, a JMS provider operates as a transactional resource manager which must participate in JTA transactions as defined in the Java EE platform specification. This overrides the behaviour of JMS sessions as defined elsewhere in the JMS specification. For more details see section 10.3 "Behaviour of JMS sessions in the Java EE web or EJB container".
* The Java EE web or EJB containers need to be able to manage the threads used to run applications.
* The Java EE web and EJB containers perform connection management which may include the pooling of JMS connections.

The restrictions described in this section do not apply to the Java EE application client container.

Applications running in the Java EE web and EJB containers must not attempt to create more than one active (not closed) Session object per connection.

* If an application attempts to use the Connection object’s createSession method when an active Session object exists for that connection then a JMSException should be thrown.
* If an application attempts to use the JMSContext object's createContext method then a JMSRuntimeException should be thrown, since the first JMSContext already contains a connection and session and this method would create a second session on the same connection.

The following methods are intended for use by the application server and their use by applications running in the Java EE web or EJB container may interfere with the container's ability to properly manage the threads used in the runtime environment. They must therefore not be called by applications running in the Java EE web or EJB container:

* javax.jms.Session method setMessageListener
* javax.jms.Session method getMessageListener
* javax.jms.Session method run
* javax.jms.Connection method createConnectionConsumer
* javax.jms.Connection method createDurableConnectionConsumer

The following methods may interfere with the container's ability to properly manage the threads used in the runtime environment and must not be used by applications running in the Java EE web or EJB container:

* javax.jms.MessageConsumer method setMessageListener
* javax.jms.MessageConsumer method getMessageListener
* javax.jms.JMSContext method setMessageListener
* javax.jms.JMSContext method getMessageListener

This restriction means that applications running in the Java EE web or EJB container which need to receive messages asynchronously may only do so using message-driven beans.

The following methods may interfere with the container's management of connections and must not be used by applications running in the Java EE web or EJB container:

* javax.jms.Connection method setClientID
* javax.jms.Connection method stop
* javax.jms.Connection method setExceptionListener
* javax.jms.JMSContext method setClientID
* javax.jms.JMSContext method stop
* javax.jms.JMSContext method setExceptionListener

Applications which need to use a specific client identifier must set it on the connection factory, as described in section 4.3.2 "Client identifier"

All the methods listed in this section may throw a javax.jms.JMSException (if allowed by the method) or a javax.jms.JMSRuntimeException (if not) when called by an application running in the Java EE web or EJB container. This is recommended but not required.

## Behaviour of JMS sessions in the Java EE web or EJB container

The behaviour of a JMS session in respect of transactions and message acknowledgement is different for applications which run in a Java EE web or EJB container than it is for applications which run in a normal Java SE environment or in the Java EE application client container.

These differences also apply to JMSContext objects, since these incorporate a JMS session.

When an application creates a Session or JMSContext in a Java EE web or EJB container, and there is an active JTA transaction in progress, then the session that is created will participate in the JTA transaction and will be committed or rolled back when the JTA transaction is committed or rolled back. Any session parameters that are specified when creating the Session or JMSContext are ignored. The use of local transactions or client acknowledgement is not permitted.

This applies irrespective of whether the JTA transaction is demarcated automatically by the container or programmatically using methods on javax.transaction.UserTransaction.

The term "session parameters" here refers to the arguments that may be passed into a call to the createSession or createContext methods to specify whether the session should use a local transaction and, if the session is non-transacted, what the acknowledgement mode should be.

When an application creates a Session or JMSContext in a Java EE web or EJB container, and there is no active JTA transaction in progress, then the session that is created will be non-transacted and will be automatically-acknowledged. The use of local transactions or client acknowledgement is still not permitted. Parameters may be specified when creating the Session or JMSContext to specify whether the acknowledgement mode should be AUTO\_ACKNOWLEDGE or DUPS\_OK\_ACKNOWLEDGE. If any other session parameter values are specified they will be ignored and an acknowledgement mode of AUTO\_ACKNOWLEDGE used.

The use of local transactions or client acknowledgement is not permitted in a Java EE web or EJB container even if there is no active JTA transaction because this would require applications to be written differently depending on whether there was a JTA transaction or not.

The JMS API provides the following methods to create a session which allow the session to be defined using either the two parameters transacted and acknowledgeMode or by the single parameter sessionMode. If these methods are called in a Java EE web or EJB container then these parameters will be overridden as described above.

* javax.jms.Connection method createSession(boolean transacted, int acknowledgeMode)
* javax.jms.QueueConnection method createQueueSession(boolean transacted, int acknowledgeMode)
* javax.jms.TopicConnection method createTopicSession(boolean transacted, int acknowledgeMode)
* javax.jms.Connection method createSession(int sessionMode)

It is recommended that applications that run in the Java EE web or EJB container create a session using the following method which does not specify a parameter:

* javax.jms.Connection method createSession()

The JMS API provides the following methods to create a JMSContext which allow the session to be defined using the single parameter sessionMode. If these methods are called in a Java EE web or EJB container then this parameter will be overridden as described above.

* javax.jms.ConnectionFactory method createContext(int sessionMode)
* javax.jms.ConnectionFactory method createContext(String userName, String password, int sessionMode)

The following method to create a JMSContext from an existing JMSContext is not permitted in a Java EE web or EJB container because it would create a second session on an existing connection, which is not permitted in a java EE web or EJB container.]

* javax.jms.JMSContext method createContext(int sessionMode)

It is recommended that applications that run in the Java EE web or EJB container creates a JMSContext using one of the following methods which do not specify a sessionMode:

* javax.jms.ConnectionFactory method createContext()
* javax.jms.ConnectionFactory method createContext(String username, String password)

When programmatic transaction demarcation is being used, the session should be both created and used within an active JTA transaction.

If a Session or JMSContext is created when there is an active JTA transaction, then after that transaction is committed or rolled back the session remains available for use in any subsequent JTA transaction until the Session or JMSContext is closed.

However, if a Session or JMSContext is created when there is an active JTA transaction but is subsequently used to send or receive messages when there is no active JTA transaction then the behaviour is undefined.

Similarly, if a Session or JMSContext is created when there is no active JTA transaction but subsequently used to send or receive messages when there is an active JTA transaction then the behaviour is undefined.

The Bean Provider should not make use of the JMS request/reply paradigm (sending of a JMS message, followed by the synchronous receipt of a reply to that message) within a single transaction. Because a JMS message is typically not delivered to its final destination until the transaction commits, the receipt of the reply within the same transaction will not take place.

# Simplified JMS API

The simplified JMS API offers an alternative to the standard JMS API. It is designed to allow applications which use JMS to be simpler and less verbose than is possible when using the standard API. It was added to the JMS specification in version 2.0.

This section uses the term "standard API" to refer to the following JMS interfaces which have existing since JMS 1.1:

* javax.jms.Connection and its subtypes javax.jms.QueueConnection and javax.jms.TopicConnection.
* javax.jms.Session and its subtypes javax.jms.QueueSession and javax.jms.TopicSession.
* javax.jms.MessageProducer and its subtypes javax.jms.QueueSender and javax.jms.TopicPublisher.
* javax.jms.MessageConsumer and its subtypes javax.jms.QueueReceiver and javax.jms.TopicSubscriber.

The term "simplified API" refers to the following JMS interfaces and classes which were added in JMS 2.0:

* javax.jms.JMSContext
* javax.jms.JMSConsumer
* javax.jms.JMSProducer
* javax.jms.JMSRuntimeException and its subtypes javax.jms.IllegalStateRuntimeException, javax.jms.InvalidClientIDRuntimeException, javax.jms.InvalidDestinationRuntimeException, javax.jms.InvalidSelectorRuntimeException, javax.jms.JMSSecurityRuntimeException, javax.jms.MessageFormatRuntimeException and javax.jms.TransactionRolledBackRuntimeException.

All the other interfaces and classes in the JMS API can be considered as part of both APIs. This includes:

* javax.jms.ConnectionFactory and its subtypes javax.jms.QueueConnectionFactory and javax.jms.TopicConnection
* javax.jms.Message and its subtypes javax.jms.ObjectMessage, javax.jms.TextMessage, javax.jms.MapMessage, javax.jms.StreamMessage, javax.jms.BytesMessage
* javax.jms.JMSException and its subtypes javax.jms.IllegalStateException, javax.jms.InvalidClientIDException, javax.jms.InvalidDestinationException, javax.jms.InvalidSelectorException, javax.jms.JMSSecurityException, javax.jms.MessageFormatException and javax.jms.TransactionRolledBackException.

## Goals of the simplified API

The simplified API has the following goals:

* To reduce the number of objects needed to send and receive messages, and in particular to combine the JMS Connection, Session and MessageProducer objects into a single object.
* To maintain a consistent style with the existing API where possible so that users of the old API feel it to be an evolution which that can learn quickly. In particular the simplified API will continue to use the concepts of connection and session even though it doesn't require the use of Connection or Session objects.
* To be capable of use in both Java EE and Java SE applications.
* To allow resource injection to be exploited in those environment which support it.
* To provide the option to send and receive the message body directly without the need to use javax.jms.Message objects.
* To remove where possible the need to catch JMSException on method calls
* To be functionally as complete as the standard API, so that users of the simplified API will not have the need to switch back to the standard API in order to perform an operation this is unavailable in the simplified API.
* To be an alternative to, but not a replacement for, the standard API. The standard API remains and is not deprecated. Developers who are familiar with the standard API, or who prefer it, may continue to use the standard API.

## Key features of the simplified API

### JMSContext

The main object in the simplified API is javax.jms.JMSContext. This combines in a single object the functionality of several separate objects from the standard API. In particular it combines the functionality of a Connection and a Session in a single object.

Although the JMSContext does not expose constituent Connection and Session objects to applications, the concepts of connection and session remain important. A Connection represents a physical link to the JMS server, a Session represents a single-threaded context for sending and receiving messages, and a JMSContext represents both.

Applications that send messages will use the JMSContext method createProducer to create a javax.jms.JMSProducer object. This provides API to send messages. Although it provides similar functionality to an anonymous MessageProducer (one with no destination specified) it provides a more convenient API for configuring delivery options, message properties and message headers. See section 11.2.3 "Sending messages" for more information.

Applications that consume messages will use one of several methods on JMSContext to create a javax.jms.JMSConsumer object. This provides similar API to a MessageConsumer for consuming messages from a particular queue or topic. Messages may be consumed either synchronously or asynchronously, except in a Java EE web or EJB container where messages may be consumed only synchronously. See section 11.2.5 "Consuming messages" for more information.

A JMSContext object may be created by calling one of four methods on a ConnectionFactory:

| ConnectionFactory methods to create a JMSContext | |
| --- | --- |
| createContext() | Creates a JMSContext with the default user identity and an unspecified sessionMode. |
| createContext(  int sessionMode) | Creates a JMSContext with the default user identity and the specified session mode. |
| createContext(  String userName,   String password) | Creates a JMSContext with the specified user identity and an unspecified sessionMode. |
| createContext(  String userName,   String password,  int sessionMode) | Creates a JMSContext with the specified user identity and the specified session mode. |

sessionMode here has the same meaning and values as for the createSession(int sessionMode) method on a Connection.

Applications running in the Java EE web and EJB containers are not permitted to create more than one active session on a connection (see Section 10.2 "Restrictions on the use of JMS API in the Java EE web or EJB container"). Since a JMSContext contains a single connection and a single session it is ideally suited for use by such applications.

Applications running in a Java SE environment or in the Java EE application client container are permitted to create multiple active sessions on the same connection. This allows the same physical connection to be used in multiple threads simultaneously. Such applications which require multiple sessions to be created on the same connection should use the factory methods on the ConnectionFactory interface to create the first JMSContext and then use the createContext method on JMSContext to create additional JMSContext objects that use the same connection:

|  |  |
| --- | --- |
| JMSContext methods to create a new JMSContext | |
| createContext(  int sessionMode) | Creates a new JMSContext with the specified session mode using the same connection as this JMSContext and creating a new session. |

To simplify application code, methods on JMSContext throw unchecked exceptions rather than checked exceptions. See section 11.2.9 "Exceptions" for more information.

### Static constants for session mode

New static integer constants have been defined for use with the simplified API.

JMSContext.AUTO\_ACKNOWLEDGE,  
JMSContext.CLIENT\_ACKNOWLEDGE,   
JMSContext.DUPS\_OK\_ACKNOWLEDGE and   
JMSContext.SESSION\_TRANSACTED

These have the same values, and the same meaning, as the equivalent constants on Session. This avoids the need for applications that use the new API to use the Session interface.

### Creating messages

An application using the standard API creates messages objects using methods on the Session.

An application using the simplified API may create messages using methods on the JMSContext. These methods are identical in behaviour to the corresponding methods on Session.

| JMSContext methods to create a message | |
| --- | --- |
| createMessage() | Creates a Message object. |
| createBytesMessage() | Creates a BytesMessage object. |
| createMapMessage() | Creates a MapMessage object. |
| createObjectMessage() | Creates an ObjectMessage object. |
| createObjectMessage(  Serializable object) | Creates an initialized ObjectMessage object. |
| createStreamMessage() | Creates a StreamMessage object. |
| createTextMessage() | Creates a TextMessage object. |
| createTextMessage(String text) | Creates an initialized TextMessage object. |

### Sending messages

An application using the standard API sends messages using methods on MessageProducer.

An application using the simplified API does not create a MessageProducer. Instead it uses the JMSContext method createProducer to create a JMSProducer object. This provides a method send(Destination destination, Message message) which will send the specified message to the specified destination.

| JMSContext method to send a Message object | |
| --- | --- |
| send(  Destination destination,  Message message) | Sends a message to the specified destination, using any send options, message properties and message headers that have been defined on this JMSProducer. |

A JMSProducer is similar to an anonymous MessageProducer in that it does not have a destination associated with it. The Destination object must therefore be supplied as the first argument of each send method.

Destination objects can be obtained either by JNDI lookup or by calling the JMSContext methods createQueue(String queueName) or createTopic (String topicName).

A JMSProducer object provides four further send methods which allow the application to supply the message body directly as a String, Serializable, Map or byte[]. The JMSProducer will automatically construct a Message object of the appropriate type to hold the specified body:

| JMSContext methods to send a Message body | |
| --- | --- |
| send(  Destination destination,  String body) | Send a TextMessage with the specified body to the specified destination, using any send options, message properties and message headers that have been defined on this JMSProducer. |
| send(  Destination destination,  Map<String,Object>  body) | Send a MapMessage with the specified body to the specified destination, using any send options, message properties and message headers that have been defined on this JMSProducer. |
| send(  Destination destination,  byte[] body) | Send a BytesMessage with the specified body to the specified destination, using any send options, message properties and message headers that have been defined on this JMSProducer. |
| send(  Destination destination,  Serializable body) | Send an ObjectMessage with the specified body to the specified destination, using any send options, message properties and message headers that have been defined on this JMSProducer. |

A JMSProducer also provides methods to allow message send options, message properties and message headers to be specified prior to sending a message or set of messages.

Message send options may be specified using one or more of the following methods: setDeliveryMode, setPriority, setTimeToLive, setDeliveryDelay, setDisableMessageTimestamp, setDisableMessageID and setAsync.

By default messages are sent synchronously. The method setAsync(CompletionListener cl) may be used to specify that messages should be sent asynchronously.

Message properties may be specified using one or more of nine setProperty methods. Any message properties set using these methods will override any message properties that have been set directly on the message.

Message headers may be specified using one or more of the following methods: setJMSCorrelationID, setJMSCorrelationIDAsBytes, setJMSType or setJMSReplyTo. Any message headers set using these methods will override any message headers that have been set directly on the message.

All the above methods return the JMSProducer to allow method calls to be chained together, allowing a fluid programming style. For example:

context.createProducer().

setProperty("foo", "bar").

setTimeToLive(10000).

setDeliveryMode(NON\_PERSISTENT).

setDisableMessageTimestamp(true).

send(inboundQueue, body);

Instances of JMSProducer are intended to be lightweight objects which can be created freely and which do not consume significant resources. JMSProducer therefore does not provide a close method.

To simplify application code, methods on JMSProducer throw unchecked exceptions rather than checked exceptions. See section 11.2.9 "Exceptions" for more information.

### Consuming messages

An application using the standard API to consume messages needs to create a MessageConsumer on the specified destination. It then either calls setMessageListener to consume messages asynchronously or calls one of three receive methods to receive messages synchronously.

An application using the simplified API does not create a MessageConsumer. Instead it uses of several methods on JMSContext to create a JMSConsumer on the specified destination. The application then either calls setMessageListener to consume messages asynchronously or calls any of six receive methods to consume messages synchronously.

The following methods on JMSContext are used to create a JMSConsumer:

|  |  |
| --- | --- |
| JMSContext methods to create a JMSConsumer | |
| createConsumer(  Destination destination) | Creates a JMSConsumer for the specified destination. |
| createConsumer(  Destination destination,  String messageSelector) | Creates a JMSConsumer for the specified destination, using a message selector. |
| createConsumer(  Destination destination,  String messageSelector,  boolean noLocal) | Creates a JMSConsumer for the specified destination, using a message selector and the noLocal parameter. |
| createDurableConsumer(  Topic topic,  String name) | Creates a durable subscription with the specified name on the specified topic, and creates a JMSConsumer on that durable subscription. |
| createDurableConsumer(  Topic topic,  String name,  String messageSelector,  boolean noLocal) | Creates a durable subscription with the specified name on the specified topic, and creates a JMSConsumer on that durable subscription, specifying a message selector and the noLocal parameter. |
| createSharedConsumer(  Topic topic,   String  sharedSubscriptionName) | Creates a shared non-durable subscription with the specified name on the specified topic, and creates a JMSConsumer on that subscription. |
| createSharedConsumer(  Topic topic,   String   sharedSubscriptionName,   String messageSelector) | Creates a shared non-durable subscription with the specified name on the specified topic, specifying a message selector, and creates a JMSConsumer on that subscription |
| createSharedConsumer(  Topic topic,   String   sharedSubscriptionName,   String messageSelector,  boolean noLocal) | Creates a shared non-durable subscription with the specified name on the specified topic, specifying a message selector and the noLocal parameter, and creates a JMSConsumer on that subscription. |

The following method on JMSConsumer may be used to set a message listener to asynchronously consume messages:

| JMSConsumer methods to set a message listener | |
| --- | --- |
| setMessageListener(  MessageListener  listener) | Sets the JMSConsumer's listener to be the specified MessageListener. |

The following methods on JMSConsumer may be used to synchronously consume messages:

|  |  |
| --- | --- |
| JMSConsumer methods to synchronously consume messages | |
| receive() | Receives the next message produced for this JMSConsumer. |
| receive(long timeout) | Receives the next message produced for this JMSConsumer that arrives within the specified timeout interval. |
| receiveNoWait() | Receives the next message produced for this JMSConsumer if one is immediately available. |

In addition, the following methods on JMSConsumer may be used to receive a message body directly:

|  |  |
| --- | --- |
| JMSConsumer methods to consume message bodies directly | |
| <T> T receiveBody(  Class<T> c); | Receives the next message produced for this JMSConsumer and returns its body as an object be of the specified type |
| <T> T receiveBody(  Class<T> c,   long timeout); | Receives the next message produced for this JMSConsumer and that arrives within the specified timeout period, and returns its body as an object of the specified type |
| <T> T receiveBodyNoWait(  Class<T> c); | Receives the next message produced for this JMSConsumer and returns its body as an object of the specified type |

These methods may be used when receiving messages of type TextMessage, ObjectMessage, MapMessage or BytesMessage and the application has no need to access message headers or properties.

If the next message is expected to be a TextMessage then this should be set to String.class. If the next message is expected to be a ObjectMessage then this should be set to java.io.Serializable.class. If the next message is expected to be a MapMessage then this should be set to java.util.Map.class. If the next message is expected to be a BytesMessage then this should be set to byte[].class. If the next message is not of the expected type a ClassCastException will be thrown and the message will not be delivered.

To simplify application code, methods on JMSConsumer throw unchecked exceptions rather than checked exceptions. See section 11.2.9 "Exceptions" for more information.

### Closing the JMSContext

A JMSContext needs to be closed after use using the close() method.

This closes the underlying session and any underlying producers and consumers. If there are no other active (not closed) JMSContext objects using the underlying connection then this method also closes the underlying connection.

The JMSContext interface extends the java.lang.AutoCloseable interface. This means that applications which create the JMSContext in a try-with-resources statement do not need to call the close method when the connection is no longer needed. Instead the session will be closed automatically at the end of the statement. The use of a try-with-resources statement also simplifies the handling of any exceptions thrown by the close method.

### Automatic start of message delivery

An application using the standard 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. This is described in section 4.3.3 "Connection setup".

The simplified API provides corresponding start and stop methods on JMSContext. The start method will be called automatically when createConsumer or createDurableConsumer are called on the MessageContext object. This means there is no need for the application to call start when the consumer is first established. As with the standard API, an application may temporarily suspend delivery by calling stop, after which a call to start will restart delivery.

Sometimes an application will need the connection to remain in stopped mode until setup is complete and not commence message delivery until the start method is explicitly called, as with the standard API. This can be configured by calling setAutoStart(false) on the JMSContext prior to calling createConsumer or createDurableConsumer.

### Threading restrictions on a JMSContext

Since a JMSContext incorporates a Session it is subject to the same threading restrictions as a Session. These are described in section 4.4.6 "Conventions for using a session" which explains how a session may only be used by one thread at a time.

The JMSContext method createContext does not use its underlying Session and so is not subject to this threading restriction.

This restriction also does not apply to the JMSContext's close method (since closing the session from another thread is permitted),

By default, when createConsumer or createDurableConsumer is used to create a JMSConsumer the connection will automatically be started. This behaviour is described in section 11.2.7 "Automatic start of message delivery". It means that if setMessageListener is called to configure the asynchronous delivery of messages then the JMSContext's session will immediately become dedicated to the thread of control that delivers messages to the listener and 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 will be responsible for ensuring that a second message listener may be safely configured even if the underlying connection has been started.

### Exceptions

Most methods in the standard API are declared as throwing a javax.jms.JMSException or a subtype of it. This means that the calling method must either catch this exception or declare it in its own throws statement.

The simplified API does not throw checked exceptions. Instead, equivalent unchecked exceptions are thrown instead.

The new unchecked exceptions, and the checked exceptions to which they correspond are listed below:

|  |  |
| --- | --- |
| Old checked exception | Corresponding new unchecked exception |
| JMSException | JMSRuntimeException |
| TransactionRolledBack Exception | TransactionRolledBack RuntimeException |
| IllegalStateException | IllegalStateRuntimeException |
| InvalidDestination Exception | InvalidDestination RuntimeException |
| InvalidSelectorException | InvalidSelectorRuntimeException |
| MessageFormatException | MessageFormatRuntimeException |
| JMSSecurityException | JMSSecurityRuntimeException |
| InvalidClientID Exception | InvalidClientID RuntimeException |

## Injection of JMSContext objects

### Support for injection

Injection of JMSContext objects is supported in those Java EE application classes which support dependency injection using CDI and for which CDI support has been enabled by means of a META\_INF/beans.xml descriptor.

Section EE.5.24 of the Java EE specification lists the application classes that support dependency injection using CDI.

Section 12.1 of the CDI specification specifies how CDI support may be enabled for a particular application.

### Container-managed and application-managed JMSContexts

A JMSContext object which has been injected is described as being *container-managed*, as it is created and closed by the container, not the application.

A JMSContext object which has been created by calling the ConnectionFactory method createContext is described as being *application-managed*. The application is responsible for calling close when the object is not longer needed.

### Injection syntax

Applications may declare a field of type javax.jms.JMSContext and annotate it with the javax.inject.Inject annotation:

@Inject

private JMSContext context;

The container will inject a JMSContext. This object will have a scope as defined by section 11.3.3 "Scope of injected JMSContext objects".

The annotation javax.jms.JMSConnectionFactory may be used to specify the JNDI lookup name of the ConnectionFactory used to create the JMSContext. For example:

@Inject

@JMSConnectionFactory("jms/connectionFactory")

private JMSContext context;

If no lookup name is specified or the JMSConnectionFactory annotation is omitted then the platform default JMS connection factory will be used.

The annotation javax.jms.JMSPasswordCredential may be used to specify a user name and password which will be used when the JMSContext is created. For example:

@Inject

@JMSConnectionFactory("jms/connectionFactory")

@JMSPasswordCredential(userName="admin",password="mypassword")

private JMSContext context;

Since it is undesirable to hardcode clear text passwords in an application, the password may be specified as an alias:

@Inject

@JMSPasswordCredential(

username="admin", password="${ALIAS=myAdminPassword}")

private JMSContext context;

The use of a password alias allows the password to be defined in a secure manner separately from the application. See the Java EE 7 platform specification for more information on password aliases.

The annotation javax.jms.JMSSessionMode may be used to specify the session mode of the JMSContext. For example:

@Inject

@JMSConnectionFactory("jms/connectionFactory")

@JMSSessionMode(JMSContext.AUTO\_ACKNOWLEDGE)

private JMSContext context;

The meaning and possible values of session mode are the same as for the ConnectionFactory method createContext(int sessionMode):

* In the Java EE application client container, session mode may be set to any of JMSContext.SESSION\_TRANSACTED, JMSContext.CLIENT\_ACKNOWLEDGE, JMSContext.AUTO\_ACKNOWLEDGE or JMSContext.DUPS\_OK\_ACKNOWLEDGE. If no session mode is specified or the JMSSessionMode annotation is omitted a session mode of JMSContext.AUTO\_ACKNOWLEDGE will be used.
* In a Java EE web or EJB container, when there is an active JTA transaction in progress, session mode is ignored and the JMSSessionMode annotation is unnecessary.
* In a Java EE web or EJB container, when there is no active JTA transaction in progress, session mode may be set to either of JMSContext.AUTO\_ACKNOWLEDGE or JMSContext.DUPS\_OK\_ACKNOWLEDGE. If no session mode is specified or the JMSSessionMode annotation is omitted a session mode of JMSContext.AUTO\_ACKNOWLEDGE will be used.

For more information about the use of session mode when creating a messaging context, see section 10.3 "Behaviour of JMS sessions in the Java EE web or EJB container" and the API documentation for the ConnectionFactory method createContext(int sessionMode).

### Scope of injected JMSContext objects

The scope of an injected JMSContext defines whether different injected JMSContext objects will actually refer to the same JMSContext object

It also defines when the injected JMSContext will be closed by the container. When the object falls out of scope, the container will automatically call close().

The scope of an injected JMSContext object will depend on whether it is used in a transaction.

* If an injected JMSContext is used in a JTA transaction (both bean-managed and container-managed), its scope will be @TransactionScoped. This scope is defined in the JTA specification. This means that:
  + The JMSContext object will be automatically created the first time it is used within the transaction.
  + The JMSContext object will be automatically closed when the transaction is committed or rolled back.
  + Within the same JTA transaction, JMSContext objects injected using identical annotations will refer to the same JMSContext object.
* If an injected JMSContext is used when there is no JTA transaction then its scope will be @RequestScoped. This scope is defined in the CDI specification. This means that:
  + The JMSContext object will be automatically created the first time it is used within a request.
  + The JMSContext object will be automatically closed when the request ends.
  + Within the same request, JMSContext objects injected using identical annotations will refer to the same JMSContext object.
* If an injected JMSContext is used both in a JTA transaction and outside a JTA transaction then separate JMSContext objects will be used, with a separate JMSContext object being used for each JTA transaction as described above.

### Restrictions on use of injected JMSContext objects

Within the same scope, different injected JMSContext objects which are injected using identical annotations will all refer to the same JMSContext object.

This means that they will all use the same connection. This will reduce the resource usage of the application and improve performance.

It also means that messages would be sent using the same session. Messages sent using different JMSContext objects in the same scope will be therefore received in order in which they were sent (see section 4.4.10.2 "Order of message sends" for a few qualifications).

However, to avoid the possibility of code in one bean having an unexpected effect on a different bean, the following methods which change the public state of a JMSContext will not be permitted if the JMSContext is injected.

* setClientID
* setExceptionListener
* stop
* acknowledge
* commit
* rollback
* recover
* setAutoStart
* start
* close

These methods must throw a IllegalStateRuntimeException if the JMSContext is injected. These restrictions do not apply when the JMSContext is managed by the application; though note that several of these methods are in any case prohibited in a Java EE web or EJB container.

## Examples using the simplified API

The examples in this section compare the use of the standard and simplified JMS APIs for some common JMS operations.

### Sending a message (Java EE)

This example compares the use of the standard and simplified JMS APIs for sending a TextMessage in a Java EE web or EJB container.

#### Example using the standard API

Here’s how you might do this using the standard API:

@Resource(lookup = "jms/connectionFactory ")  
ConnectionFactory connectionFactory;

@Resource(lookup="jms/inboundQueue")

Queue inboundQueue;

public void sendMessageOld (String body) throws JMSException{

try (Connection connection =

connectionFactory.createConnection()) {

Session session = connection.createSession();

MessageProducer messageProducer =

session.createProducer(inboundQueue);

TextMessage textMessage =

session.createTextMessage(body);

messageProducer.send(textMessage);

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API:

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup="jms/inboundQueue")

Queue inboundQueue;

public void sendMessageNew (String body) {

try (JMSContext context = connectionFactory.createContext();){

context.createProducer().send(inboundQueue,body);

}

}

Note that sendMessageNew does not need to throw JMSException.

#### Example using the simplified API and injection

Here's how you might do this using the simplified API with the JMSContext created by injection:

@Inject

@JMSConnectionFactory("jms/connectionFactory")

private JMSContext context;

@Resource(mappedName = "jms/inboundQueue")

private Queue inboundQueue;

public void sendMessageNew(String body) {

context.send(inboundQueue, body);

}

### Sending a message (Java SE)

This example compares the use of the standard and simplified JMS APIs for sending a TextMessage in a Java SE environment.

#### Example using the standard API

Here’s how you might do this using the standard API:

**public** **void** sendMessageOld(String body)

**throws** JMSException, NamingException{

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

**try** (Connection connection =

connectionFactory.createConnection()) {

Session session = connection.createSession();

MessageProducer messageProducer =

session.createProducer(inboundQueue);

TextMessage textMessage = session.createTextMessage(body);

messageProducer.send(textMessage);

}

}

#### Example using the simplified API

Here’s how you might do this 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);

}

}

Note that receiveMessagesNew does not need to throw JMSException.

### Sending a message with properties (Java SE)

This example is similar to the previous example in that it compares the use of the standard and simplified JMS APIs for sending a TextMessage in a Java SE environment.

However this example also configures various attributes of the message that is sent:

* The message property "foo" is set to a value of "bar".
* The message is sent using a delivery mode of NON\_PERSISTENT.
* The JMS provider is informed that message timestamps are not required.

#### Example using the standard API

Here’s how you might do this using the standard API:

**public** **void** sendMessageOld(String body)

**throws** JMSException, NamingException{

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

**try** (Connection connection =

connectionFactory.createConnection()) {

Session session = connection.createSession();

MessageProducer messageProducer =

session.createProducer(inboundQueue);

TextMessage textMessage = session.createTextMessage(body);

textMessage.setStringProperty("foo", "bar");

messageProducer.setDeliveryMode(NON\_PERSISTENT);

messageProducer.setDisableMessageTimestamp(true);

messageProducer.send(textMessage);

}

}

#### Example using the simplified API

Here’s how you might do this 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().

setProperty("foo", "bar").

setTimeToLive(10000).

setDeliveryMode(NON\_PERSISTENT).

setDisableMessageTimestamp(true).

send(inboundQueue, body);

}

}

Note that receiveMessagesNew does not need to throw JMSException.

### Receiving a message synchronously (Java EE)

This example compares the use of the standard and simplified JMS APIs for synchronously receiving a TextMessage in a Java EE web or EJB container.

#### Example using the standard API

Here’s how you might do this using the standard API:

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup="jms/inboundQueue")

Queue inboundQueue;

public String receiveMessageOld() throws JMSException {

try (Connection connection =  
 connectionFactory.createConnection()) {

connection.start();

Session session = connection.createSession();

MessageConsumer messageConsumer =  
 session.createConsumer(inboundQueue);

TextMessage textMessage =

(TextMessage)messageConsumer.receive();

String body = textMessage.getText();

return body;

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API.

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup="jms/inboundQueue")

Queue inboundQueue;

public String receiveMessageNew() {

try (JMSContext context = connectionFactory.createContext()) {

JMSConsumer consumer = context.createConsumer(inboundQueue);

return consumer.receivePayload(String.class);

}

}

Note that receiveMessageNew does not need to throw JMSException.

#### Example using the simplified API and injection

Here's how you might do this using the simplified API with the JMSContext created by injection:

@Inject

@JMSConnectionFactory("jms/connectionFactory")

private JMSContext context;

@Resource(lookup="jms/inboundQueue")

Queue inboundQueue;

public String receiveMessageNew() {

JMSConsumer consumer = context.createConsumer(inboundQueue);

return consumer.receivePayload(String.class);

}

### Receiving a message synchronously (Java SE)

This example compares the use of the standard and simplified JMS APIs for synchronously receiving a TextMessage in a Java SE environment.

#### Example using the standard API

Here’s how you might do this using the standard API:

public String receiveMessageOld()

throws JMSException, NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

try (Connection connection =

connectionFactory.createConnection();){

Session session = connection.createSession(AUTO\_ACKNOWLEDGE);

MessageConsumer messageConsumer =

session.createConsumer(inboundQueue);

connection.start();

TextMessage textMessage=

(TextMessage) messageConsumer.receive();

return textMessage.getText();

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API.

public String receiveMessageNew() throws NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

try (JMSContext context =

connectionFactory.createContext(AUTO\_ACKNOWLEDGE);) {

JMSConsumer consumer = context.createConsumer(inboundQueue);

return consumer.receivePayload(String.class);

}

}

Note that receiveMessageNew does not need to throw JMSException.

### Receiving a message synchronously from a durable subscription (Java EE)

This example compares the use of the standard and simplified JMS APIs for synchronously receiving a TextMessage from a durable topic subscription in a Java EE web or EJB container.

#### Example using the standard API

Here’s how you might do this using the standard API.

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup = "jms/inboundTopic")

Topic inboundTopic;

public String receiveMessageOld() throws JMSException {

try (Connection connection =

connectionFactory.createConnection()) {

Session session = connection.createSession();

MessageConsumer messageConsumer =

session.createDurableConsumer(inboundTopic, "mysub");

connection.start();

TextMessage textMessage =

(TextMessage) messageConsumer.receive();

return textMessage.getText();

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API.

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup="jms/inboundTopic")

Topic inboundTopic;

public String receiveMessageNew() {

try (JMSContext context = connectionFactory.createContext()) {

JMSConsumer consumer =

context.createDurableConsumer(inboundTopic, "mysub");

return consumer.receivePayload(String.class);

}

}

Note that receiveMessageNew does not need to throw an exception.

#### Example using the simplified API and injection

Here's how you might do this using the simplified API with the JMSContext created by injection:

@Inject

@JMSConnectionFactory("jms/connectionFactory")

private JMSContext context;

@Resource(lookup="jms/inboundTopic")

Topic inboundTopic;

public String receiveMessageNew() {

JMSConsumer consumer =  
 context.createDurableConsumer(inboundTopic, "mysub");

return consumer.receivePayload(String.class);

}

### Receiving messages asynchronously (Java SE)

This example compares the use of the standard and simplified JMS APIs for asynchronously receiving TextMessage objects in a Java SE environment.

#### Example using the standard API

Here’s how you might do this using the standard API, using a message listener class MyListener:

public void receiveMessagesOld()

throws JMSException, NamingException{

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

try (Connection connection =

connectionFactory.createConnection();){

Session session = connection.createSession(*AUTO\_ACKNOWLEDGE*);

MessageConsumer consumer =

session.createConsumer(inboundQueue);

MessageListener messageListener = new MyListener();

consumer.setMessageListener(messageListener);

connection.start();

// wait for messages to be received - details omitted

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API.

public void receiveMessagesNew() throws NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue = (Queue)

initialContext.lookup("jms/inboundQueue");

try (JMSContext context =

connectionFactory.createContext(AUTO\_ACKNOWLEDGE);){

JMSConsumer consumer = context.createConsumer(inboundQueue);

MessageListener messageListener = new MyListener();

consumer.setMessageListener(messageListener);

// wait for messages to be received - details omitted

}

}

Note that receiveMessagesNew does not need to throw JMSException.

### Receiving a message asynchronously from a durable subscription (Java SE)

This example compares the use of the standard and simplified JMS APIs for asynchronously receiving a TextMessage from a durable topic subscription in a Java SE environment.

#### Example using the standard API

Here’s how you might do this using the standard API, using a message listener class MyListener:

public void receiveMessagesOld()

throws JMSException, NamingException{

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Topic inboundTopic =

(Topic)initialContext.lookup("jms/inboundTopic");

try (Connection connection =

connectionFactory.createConnection();) {

Session session =

connection.createSession( AUTO\_ACKNOWLEDGE);

session.createDurableSubscriber(inboundTopic, "");

TopicSubscriber topicSubscriber =

session.createDurableSubscriber(inboundTopic, "mysub");

MessageListener messageListener = new MyListener();

topicSubscriber.setMessageListener(messageListener);

connection.start();

// wait for messages to be received - details omitted

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API:

public void receiveMessagesNew() throws NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Topic inboundTopic =

(Topic) initialContext.lookup("jms/inboundTopic");

try (JMSContext context =

connectionFactory.createContext(AUTO\_ACKNOWLEDGE);){

JMSConsumer consumer =

context.createDurableConsumer(inboundTopic, "mysub");

MessageListener messageListener = new MyListener();

consumer.setMessageListener(messageListener);

// wait for messages to be received - details omitted

}

}

Note that receiveMessagesNew does not need to throw JMSException.

### Receiving messages in multiple threads (Java SE)

This example compares the use of the standard and simplified JMS APIs for asynchronously receiving TextMessage objects from a queue using multiple threads in a Java SE environment. In this example two threads are used, which means two sessions are needed. In this example, both sessions use the same connection.

#### Example using the standard API

Here’s how you might do this using the standard API, using a message listener class MyListener:

public void receiveMessagesOld()

throws JMSException, NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

try (Connection connection =

connectionFactory.createConnection();){

Session s1 = connection.createSession(AUTO\_ACKNOWLEDGE);

MessageConsumer messageConsumer1 =

s1.createConsumer(inboundQueue);

MyListener messageListener1 = new MyListener("One");

messageConsumer1.setMessageListener(messageListener1);

Session s2 = connection.createSession(AUTO\_ACKNOWLEDGE);

MessageConsumer messageConsumer2 =

s2.createConsumer(inboundQueue);

MyListener messageListener2 = new MyListener("Two");

messageConsumer2.setMessageListener(messageListener2);

connection.start();

// wait for messages to be received - details omitted

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API:

public void receiveMessagesNew() throws NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

try (JMSContext context1 =

connectionFactory.createContext(AUTO\_ACKNOWLEDGE);

JMSContext context2 =

context1.createContext(AUTO\_ACKNOWLEDGE);){

JMSConsumer consumer1 =

context1.createConsumer(inboundQueue);

MyListener messageListener1 = new MyListener("One");

consumer1.setMessageListener(messageListener1);

JMSConsumer consumer2 =

context2.createConsumer(inboundQueue);

MyListener messageListener2 = new MyListener("Two");

consumer2.setMessageListener(messageListener2);

// wait for messages to be received - details omitted

}

}

### Receiving synchronously and sending a message in the same local transaction (Java SE)

This example compares the use of the standard and simplified JMS APIs for the use case in which a Java SE application repeatedly consumes a message from one queue and forwards it to another queue in a Java SE environment. In this example each message is received and forwarded in the same local transaction. This means that the receiving and sending of the message must be done using the same transacted session which is then committed.

In this example the application consumes the incoming messages synchronously. However since this is a Java SE application the message could also be consumed asynchronously using a MessageListener.

#### Example using the standard API

Here’s how you might do this using the standard API:

public void receiveAndSendMessageOld()

throws JMSException, NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

Queue outboundQueue =

(Queue) initialContext.lookup("jms/outboundQueue");

try (Connection connection =

connectionFactory.createConnection();){

Session session =  
 connection.createSession(SESSION\_TRANSACTED);

MessageConsumer messageConsumer =

session.createConsumer(inboundQueue);

MessageProducer messageProducer =

session.createProducer(outboundQueue);

connection.start();

TextMessage textMessage = null;

do {

textMessage = (TextMessage) messageConsumer.receive(1000);

if (textMessage!=null){

messageProducer.send(textMessage);

session.commit();

}

} while (textMessage!=null);

}

}

#### Example using the simplified API

Here’s how you might do this using the simplified API:

public void receiveAndSendMessageNew() throws NamingException {

InitialContext initialContext = getInitialContext();

ConnectionFactory connectionFactory = (ConnectionFactory)

initialContext.lookup("jms/connectionFactory");

Queue inboundQueue =

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

Queue outboundQueue =

(Queue) initialContext.lookup("jms/outboundQueue");

try (JMSContext context =

connectionFactory.createContext(SESSION\_TRANSACTED);){

JMSConsumer consumer = context.createConsumer(inboundQueue);

TextMessage textMessage = null;

do {

textMessage = (TextMessage) consumer.receive(1000);

if (textMessage != null) {

context.createProducer().send(

outboundQueue, textMessage);

context.commit();

}

} while (textMessage != null);

}

}

Note that receiveAndSendMessageNew does not need to throw JMSException.

### Request/reply pattern using a TemporaryQueue (Java EE)

This example compares the use of the standard and simplified JMS APIs for implementing a request/reply pattern in a Java EE EJB container.

In this example, a session bean (the requestor) sends a request message to some queue (the request queue). The setJMSReplyTo property of the request message is set to a TemporaryQueue, to which the reply should be set. After sending the request, the session bean listens on the temporary queue until it receives the reply.

Since the request message won’t actually be sent until the transaction is committed, the request message is sent in a separate transaction from that used to receive the reply.

A message-driven bean (the responder) listens on the request queue for request messages. When it receives a message it creates a reply message and sends it to the reply queue specified in the setJMSReplyTo property of the incoming message.

When implementing this pattern, the following features of JMS must be borne in mind:

* The same Connection object that was used to create the TemporaryQueue must also be used to consume the response message from it. (This is a restriction of temporary queues).
* If the request message is sent in a transaction then the response message must be consumed in a separate transaction. That’s why the message is sent in a separate business which has the transactional attribute REQUIRES\_NEW.

#### Example using the standard API

Here’s how you might implement the requestor this using the standard API:

There are two session beans involved in sending the request message. The first bean

The first session bean RequestReplyOld creates the creates the temporary reply queue, calls a second bean SenderBeanOld to send the request in a separate transaction and then listens for the reply:

@Stateless

@LocalBean

public class RequestReplyOld {

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@EJB private SenderBeanOld senderBean;

@TransactionAttribute(TransactionAttributeType.REQUIRED)

public String requestReplyOld(String request) throws JMSException {

try (Connection connection =

connectionFactory.createConnection()) {

Session session = connection.createSession();

TemporaryQueue replyQueue = session.createTemporaryQueue();

// call a second bean to

// send the request message in a separate transaction

senderBean.sendRequestOld(request,replyQueue);

// now receive the reply, using the same connection

// as was used to create the temporary reply queue

MessageConsumer consumer= session.createConsumer(replyQueue);

connection.start();

TextMessage reply = (TextMessage) consumer.receive();

return reply.getText();

}

}

}

The second session bean SenderBeanOld simply sends the request to the request queue in a separate transaction:

@Stateless

@LocalBean

public class SenderBeanOld {

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup="jms/requestQueue")

Queue requestQueue;

@TransactionAttribute(TransactionAttributeType.REQUIRES\_NEW)

public void sendRequestOld(

String requestString, TemporaryQueue replyQueue)

throws JMSException {

try (Connection connection =

connectionFactory.createConnection()) {

Session session = connection.createSession();

TextMessage requestMessage =

session.createTextMessage(requestString);

requestMessage.setJMSReplyTo(replyQueue);

MessageProducer messageProducer =

session.createProducer(requestQueue);

messageProducer.send(requestMessage);

}

}

}

Here is the message-driven bean RequestResponderOld which receives request messages and sends responses:

@MessageDriven(mappedName = "jms/requestQueue")

public class RequestResponderOld implements MessageListener {

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

public void onMessage(Message message) {

try (Connection connection =

connectionFactory.createConnection()){

Session session = connection.createSession();

// extract request from request message

String request = ((TextMessage)message).getText();

// extract temporary reply destination from request message

Destination replyDestination = message.getJMSReplyTo();

// prepare response

TextMessage replyMessage =

session.createTextMessage("Reply to: "+request);

// send response

MessageProducer messageProducer =

session.createProducer(replyDestination);

messageProducer.send(replyMessage);

} catch (JMSException ex) {

// log an error here

}

}

}

#### Example using the simplified API

Here’s how the same example might look when using the simplified API:

There are two session beans involved in sending the request message. The first bean

The first session bean RequestReplyNew creates the creates the temporary reply queue, calls a second bean SenderBeanNew to send the request in a separate transaction and then listens for the reply:

@Stateless

@LocalBean

public class RequestReplyNew {

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@EJB private SenderBeanNew senderBean;

@TransactionAttribute(TransactionAttributeType.REQUIRED)

public String requestReplyNew(String request) throws JMSException {

try (JMSContext context = connectionFactory.createContext()) {

TemporaryQueue replyQueue = context.createTemporaryQueue();

// send the request message in a separate transaction

// so use a separate bean

// this call may throw JMSException

senderBean.sendRequestNew(request,replyQueue);

// now receive the reply, using the same connection

// as was used to create the temporary reply queue

JMSConsumer consumer = context.createConsumer(replyQueue);

return consumer.receivePayload(String.class);

}

}

}

The second session bean SenderBeanNew simply sends the request to the request queue in a separate transaction:

@Stateless

@LocalBean

public class SenderBeanNew {

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

@Resource(lookup="jms/requestQueue")

Queue requestQueue;

@TransactionAttribute(TransactionAttributeType.REQUIRES\_NEW)

public void sendRequestNew(

String requestString, TemporaryQueue replyQueue)

throws JMSException {

try (JMSContext context = connectionFactory.createContext()) {

TextMessage requestMessage =

context.createTextMessage(requestString);

// this call may throw JMSException

requestMessage.setJMSReplyTo(replyQueue);

context.createProducer().send(

requestQueue,requestMessage);

}

}

}

Here is the message-driven bean RequestResponderNew which receives request messages and sends responses:

@MessageDriven(mappedName = "jms/requestQueue")

public class RequestResponderNew implements MessageListener {

@Resource(lookup = "jms/connectionFactory")

ConnectionFactory connectionFactory;

public void onMessage(Message message) {

try (JMSContext context = connectionFactory.createContext()){

// extract request from request message

// this may throw a JMSException

String request = ((TextMessage)message).getText();

// extract temporary reply destination from request message

// this may throw a JMSException

Destination replyDestination = message.getJMSReplyTo();

// prepare response

TextMessage replyMessage =

context.createTextMessage("Reply to: "+request);

// send response

context.createProducer().send(replyDestination,replyMessage);

} catch (JMSException ex) {

// log an error here

}

}

}

Note that in this example it is not possible to eliminate the need to declare to catch JMSException since it uses methods on Message and TextMessage which throw JMSException.

#### Example using the simplified API and injection

Here's how the same example might look when using the simplified API with the JMSContext created by injection:

There are two session beans involved in sending the request message. The first bean

The first session bean RequestReplyNew creates the creates the temporary reply queue, calls a second bean SenderBeanNew to send the request in a separate transaction and then listens for the reply:

@Stateless

@LocalBean

public class RequestReplyNew {

@Inject

@JMSConnectionFactory("jms/connectionFactory2")

private JMSContext context;

@EJB private SenderBeanNew senderBean;

@TransactionAttribute(TransactionAttributeType.REQUIRED)

public String requestReplyNew(String request) throws JMSException {

TemporaryQueue replyQueue = context.createTemporaryQueue();

// send the request message in a separate transaction

// so use a separate bean

// this call may throw JMSException

senderBean.sendRequestNew(request,replyQueue);

// now receive the reply, using the same connection

// as was used to create the temporary reply queue

JMSConsumer consumer = context.createConsumer(replyQueue);

return consumer.receivePayload(String.class);

}

}

The second session bean SenderBeanNew simply sends the request to the request queue in a separate transaction:

@Stateless

@LocalBean

public class SenderBeanNew {

@Inject

@JMSConnectionFactory("jms/connectionFactory")

private JMSContext context;

@Resource(lookup="jms/requestQueue")

Queue requestQueue;

@TransactionAttribute(TransactionAttributeType.REQUIRES\_NEW)

public void sendRequestNew(

String requestString, TemporaryQueue replyQueue)

throws JMSException {

TextMessage requestMessage =

context.createTextMessage(requestString);

// this call may throw JMSException

requestMessage.setJMSReplyTo(replyQueue);

context.createProducer().send(requestQueue,requestMessage);

}

}

Here is the message-driven bean RequestResponderNew which receives request messages and sends responses:

@MessageDriven(mappedName = "jms/requestQueue")

public class RequestResponderNew implements MessageListener {

@Inject

@JMSConnectionFactory("jms/connectionFactory")

private JMSContext context;

public void onMessage(Message message) {

try {

// extract request from request message

// this may throw a JMSException

String request = ((TextMessage)message).getText();

// extract temporary reply destination from request message

// this may throw a JMSException

Destination replyDestination = message.getJMSReplyTo();

// prepare response

TextMessage replyMessage =

context.createTextMessage("Reply to: "+request);

// send response

context.createProducer().send(replyDestination,replyMessage);

} catch (JMSException ex) {

// log an error here

}

}

}

Note that in this example it is not possible to eliminate the need to declare to catch JMSException since it uses methods on Message and TextMessage which throw JMSException.

# Resource Adapter

The Java EE Connector Architecture (JCA) specification defines a standard architecture for connecting the Java EE platform to enterprise information systems (EISs).

A JMS provider is required to include a resource adapter which connects to that JMS provider and which conforms to the Java EE Connector Architecture specification and as further specified in this chapter. Such a resource adapter is referred a "JMS standard resource adapter".

The version of the Java EE Connector Architecture specification which should be used is 1.6.

This chapter is not intended to prevent the creation and use of additional resource adapters for connecting to a JMS provider which do not conform to the specifications in this chapter. However Java EE applications which use such resource adapters may be less portable.

## ActivationSpec properties

A JMS standard resource adapter must support the ActivationSpec JavaBean properties defined in the following table. It may support additional properties in addition to those listed.

Table 12.1ActivationSpec properties that a JMS standard resource adapter must support

| **ActivationSpec property** | **Description** |
| --- | --- |
| destinationLookup | This property may be used to specify the lookup name of an administratively-defined javax.jms.Queue or javax.jms.Topic object which defines the JMS queue or topic from which the endpoint (message-driven bean) is to receive messages. |
| connectionFactoryLookup | This property may be used to specify the lookup name of an administratively-defined javax.jms.ConnectionFactory, javax.jms.QueueConnectionFactory or javax.jms.TopicConnectionFactory object that will be used to connect to the JMS provider from which the endpoint (message-driven bean) is to receive messages. |
| acknowledgeMode | If bean-managed transaction demarcation is used, this property may be used to indicate whether JMS AUTO\_ACKNOWLEDGE semantics or DUPS\_OK\_ACKNOWLEDGE semantics should apply.  This property may be set to either Auto-acknowledge or Dups-ok-acknowledge. If this property is not specified, a default of Auto-acknowledge will be used. |
| messageSelector | This property may be used to specify a message selector. If this property is not specified then a message selector will not be used. |
| destinationType | This property may be used to specify whether the specified destination is a queue or topic. The valid values are javax.jms.Queue or javax.jms.Topic. |
| subscriptionDurability | This property only applies to endpoints (message-driven beans) that receive messages published to a topic. It may be used to specify whether the subscription is durable or non-durable.  This property may be set to either Durable or NonDurable. If this property is not specified, a default of NonDurable will be used. |
| clientId | This property may be used to specify the client identifier that will be used when connecting to the JMS provider from which the endpoint (message-driven bean) is to receive messages.  If this property is not specified then the client identifier will be left unset. |
| subscriptionName | This property only applies to endpoints (message-driven beans) that receive messages published to a topic. If the subscriptionDurability property has been used to specify that the subscription is durable then the subscriptionName property may be used to specify the name of the durable subscription.  If a durable subscription is specified but subscriptionName is not specified then the resource adapter will set the name of the durable subscription to be a name which is unique to the deployed MDB. If the message-driven bean is deployed into a clustered application server then the shareSubscriptions property will be used to determine whether the durable subscription name generated by the resource adapter will be the same or different for each instance in the cluster.  The resource adapter may obtain the name unique to the deployed MDB by performing a JNDI lookup of the name java:comp/UniqueMDBName, as specified in the EJB 3.2 specification section 5.7.3 "Unique Identifier for JMS Message-Driven Bean". If a name different for each instance in the cluster is required the resource adapter may obtain a name that identifies the instance by performing a JNDI lookup of the name java:comp/InstanceName as specified in the Java EE 7 Platform Specification section 5.16 "Application Server Instance Name" |
| shareSubscriptions | This property only applies to message-driven beans that receive messages published to a topic and are deployed into a clustered application server.  If a durable subscription is specified but subscriptionName is not specified then the shareSubscription property may be used to specify whether the durable subscription name generated by the resource adapter should be the same or different for each instance in the cluster.  If a non-durable subscription is specified then the shareSubscription property may be used to specify whether each instance in the cluster should use the same shared non-durable subscription or whether each instance should use a separate non-shared subscription.  This property may have the string values true or false.  A value of true means that the same durable or non-durable subscription will be used for each instance in the cluster.  A value of false means that a different durable or non-durable subscription will be used for each instance in the cluster.  By default a value of true is assumed. |

1. Issues
   1. Resolved issues
      1. JDK 1.1.x compatibility

JMS is compatible with JDK 1.1.x.

* + 1. Distributed Java event model

JMS can be used, in general, as a notification service; however, it does not define a distributed version of Java Events.

One alternative for implementing distributed Java Events would be as JavaBeans that transparently, to the event producer and listener beans, distribute the events via JMS.

* + 1. Should the two JMS domains, PTP and pub/sub, be merged?

Even though there are many similarities, providing separate domains still seem to be important.

It means that vendors aren't forced to support facilities out of their domain, and that client code can be a bit more portable because products more fully support a domain (as opposed to supporting less defined subsets of a merged domain).

* + 1. Should JMS specify a set of JMS JavaBeans?

JMS is a low level API and like other Java low level API's it doesn't lend itself to direct representation as JavaBeans.

* + 1. Alignment with the CORBA notification service

The Notification service adds filtering, delivery guarantee semantics, durable connections, and the assembly of event networks to the CORBA Event Service. It gets its delivery guarantee semantics from the CORBA Messaging Service (which defines asynchronous CORBA method invocation).

Java technology is well integrated with CORBA. It provides Java IDL and COS Naming. In addition, OMG has recently defined RMI over IIOP.

It is expected that most use of IIOP from Java will be via RMI. It is expected that most use of COS Naming from Java with be via JNDI (Java Naming and Directory Service). JMS is a Java specific API designed to be layered over a wide range of existing and future MOM systems (just like JNDI is layered over existing name and directory services).

* + 1. Should JMS provide end-to-end synchronous message delivery and notification of delivery?

Some messaging systems provide synchronous delivery to destinations as a mechanism for implementing reliable applications. Some systems provide clients with various forms of delivery notification so that the clients can detect dropped or ignored messages. This is not the model defined by JMS.

JMS messaging provides guaranteed delivery via the once-and-only-once delivery semantics of PERSISTENT messages. In addition, message consumers can insure reliable processing of messages by using either CLIENT\_ACKNOWLEDGE mode or transactional sessions.

This achieves reliable delivery with minimum synchronization and is the enterprise messaging model most vendors and developers prefer.

JMS does not define a schema of systems messages (such as delivery notifications). If an application requires acknowledgment of message receipt, it can define an application level acknowledgment message.

These issues are more clearly understood when they are examined in the context of pub/sub applications. In this context, synchronous delivery and/or system acknowledgment of receipt are not an effective mechanism for implementing reliable applications (because producers by definition are not, and don’t want to be, responsible for end-to-end message delivery).

* + 1. Should JMS provide a send-to-list mechanism?

Currently JMS provides a number of message send options; however, messages can only be sent to one destination at a time.

The benefit of send-to-list is slightly less work for the programmer and the potential for the JMS provider to optimize the fact that several destinations are being sent the same message.

The down side of a send-to-list mechanism is that the list is, in effect, a group that is implemented and maintained by the client. This would complicate the administration of JMS clients.

Instead of JMS providing a send-to-list mechanism, it is recommended that providers support configuring destinations that represent a group. This allows a client to reach all consumers with a single send, while insuring that groups are properly administrable.

* + 1. Should JMS provide subscription notification?

If it were possible for a publisher to detect when subscribers for a topic existed, it could inhibit publication on unsubscribed topics.

Although there may be some benefit in providing publishers with a mechanism for inhibiting publication to unsubscribed topics, the complexity this would add to JMS and the additional provider overhead it would require is not justified by its potential benefits. Instead, JMS providers should insure that they minimize the overhead for handling messages published to an unsubscribed topic.

* 1. Unresolved issues in the JMS 2.0 Early Draft

This section has been added to assist discussion of the JMS 2.0 Early Draft and will be removed prior to final release.

* + 1. Simplified API: Injecting a JMSContext

The JMS 2.0 Early Draft release proposes how in a Java EE application JMSContext objects can be injected. See section 11.3 "Injection of JMSContext objects" for details.

The container is responsible for creating JMSContext objects and in closing them after use.

How much does the specification need to say about how such objects are managed by the container? To some extent this can be considered an implementation detail which can be left to the container. However there are cases when the application needs to know whether two successive calls to methods on a JMSContext apply to the same or different sessions, since JMS only defines the relative order of messages produced using rhe same session.

* 1. Unresolved issues in the JMS 2.0 Public Draft

This section has been added to assist discussion of the JMS 2.0 Public Draft and may be removed prior to final release if the issue has been resolved.

* + 1. Delivery delay

Delivery delay is a new feature added in JMS 2.0 and is described in section 4.12 "Delivery delay".

There is an unresolved issue regarding the delivery of messages to topics which have a delivery delay specified. This is whether the decision to add a message to a subscription (whether durable or non-durable) should be made (a) when the message reaches its delivery time or (b) when the message is sent.

Note that this is a question about deciding which subscriptions a message is added to, not about when the message would actually be delivered. In both cases the message wouldn't be delivered to a consumer until the delivery time has been reached.

If (a) were adopted it would require the JMS provider to keep all messages in the server until their delivery time is reached, even if there were no durable or non-durable subscriptions in existence. This might even be needed for non-persistent messages. Adopting (b) does not require this and by not requiring a message to be held separately from a subscription is closer to the way in which JMS providers work now. Forcing a JMS provider to implement (a) might potentially add a significant burden simply to cater for an unimportant edge case.

In this specification option (b) has been chosen, and section 4.12 "Delivery delay" states that if a message is published to a topic, it will only be added to a durable or non-durable subscription on that topic if the subscription exists at the time the message is sent and continues to exist at the time the specified message delivery time is reached.

However there were differing views on this within the JMS 2.0 expert group and further views are invited.

In addition there is an unresolved issue regarding the behaviour of a QueueBrowser. In this specification, section 5.9 "QueueBrowser" has been updated to state that "a message must not be returned by a QueueBrowser before its delivery time has been reached." However there were differing views on this within the JMS 2.0 expert group and further views are invited.

* + 1. Meaning of noLocal with shared topic subscriptions

JMS 2.0 allows multiple consumers to be created on the same durable or non-durable subscription. This means that in some cases more than one connection may be being used to consume messages from a subscription.

The definition of the noLocal parameter in JMS 1.1 was written on the basis that there would only ever be one connection at a time consuming messages from a subscription. This definition therefore became ambiguous and inadequate for JMS 2.0 and needed to be revised.

The revised definition may be found in section 6.11.2 "Shared non-durable subscriptions" and section 6.11.3 "Durable subscriptions" and in the API documentation.

The expert group had some difficulty in finding realistic use cases for the use of the noLocal parameter in the case where the subscription was shared. It would therefore particularly welcome suggestions of real-world use cases which would use this parameter, and comments on whether the proposed definition would satisfy such use cases.

* + 1. Shared durable subscriptions: small loss of backwards compatibility

JMS 2.0 allows multiple consumers to be created on the same durable or non-durable subscription.

For non-durable subscriptions this is achieved using a new method createSharedConsumer on both Session and JMSContext.

For durable subscriptions this is achieved by using the new method createDurableConsumer on Session and JMSContext or the existing method createDurableSubscriber on Session.

In this last case it has been necessary to change the specified behaviour of an existing method.

In JMS 1.1, the API documentation for the method createDurableSubscriber on Session stated that "only one session at a time can have a TopicSubscriber for a particular durable subscription". This implied that an attempt to create a second TopicSubscriber for a particular durable subscription would cause a JMSException to be thrown.

However in JMS 2.0 this behaviour is explicitly allowed. The API documentation states "a durable subscription may have more than one active consumer (this was not permitted prior to JMS 2.0). This means that application code which would cause a JMSException to be thrown in JMS 1.1 would not throw such an exception in JMS 2.0.

This is technically a violation of backwards compatibility and is therefore recorded here as an issue. Comments are invited.

If feedback indicates that this change is not acceptable then one alternative is to reinstate the old behaviour for the existing method createDurableSubscriber on Session whilst retaining the new behaviour for the new method createDurableConsumer on Session and JMSContext. This may, however, be a cause of confusion.

An alternative would be for new method createDurableConsumer on Session and JMSContext and the existing method createDurableSubscriber on Session to allow only a single consumer on the subscription, and to add a new method createSharedDurableSubscriber which would need to be used if multiple consumers per subscription were needed.

1. Change history
   1. Version 1.0.1
      1. JMS exceptions

A new JMS Exception chapter was added and it contains the following new information:

* Two fields were added to JMSException - a vendor error code and an Exception reference.
* In version 1.0, JMSException was the only JMS exception specified. Version 1.0.1 adds a list of standard exceptions derived from JMSException and describes when each should be thrown by JMS providers.
  1. Version 1.0.2

The objective of JMS 1.0.2 is to correct errata in the JMS 1.0.1 specification and code that have been uncovered by implementors and users. It also contains many clarifications that resolve ambiguities found in the previous versions.

* + 1. The multiple topic subscriber special case

JMS 1.0.1 specified that in the special case of two topic subscribers on a session with overlapping subscriptions, a message that was selected by both would only be delivered to one. Implementation experience revealed that this case was better handled in the same way that overlapping subscriptions from different sessions are treated, so this special case has been removed.

* + 1. Message selector comparison of exact and inexact numeric values

JMS 1.0.1 specified that message selectors did not support the comparison of exact and inexact numeric values. This conflicted with the requirement to support numeric promotion. This has been changed to support exact and inexact comparison.

* + 1. Connection and session close

JMS 1.0.1 did not fully specify the sequence for closing a connection and its sessions. This sequence is now fully specified.

JMS 1.0.1 was ambiguous about whether or not calls to connection and session close returned immediately. Connection and session close now explicitly state that they block until message processing has been shutdown in an orderly fashion.

* + 1. Creating a session on an active connection

When a session is created on an active (as opposed to stopped) connection it is only possible to create at most a single asynchronous consumer for it. A more detailed discussion of this case is provided.

* + 1. Delivery mode and message retention

The effect that delivery mode has on message retention for a consumer has been clarified.

* + 1. The ‘single thread’ use of sessions

Sessions are designed to minimize the need to write for multithreaded code in order to support the asynchronous consumption of messages. Clarification on the benefits and the programming model of this design have been added.

* + 1. Clearing a message’s properties and body

A clarification has been added that notes that clearing a message’s properties and clearing its body are independent.

* + 1. Message selector numeric literal syntax

A note has been added that states that the numeric literal syntax is that specified by the Java language.

* + 1. Comparison of boolean values in message selectors

A note has been added that only equality and inequality comparisons are supported.

* + 1. Order of messages read from a queue

A note has been added that explains that a client can read messages from a destination in an order different from the order they have been sent by using a selector that matches a later message and then using a selector that matches an earlier message.

* + 1. Null values in messages

A note has been added that message values are allowed to be null.

* + 1. Closing constituents of closed connections and sessions

There was some ambiguity about whether or not close needed to be called on all JMS objects. A note has been added that states that there is no need to close the sessions of a closed connection; and, there is no need to close the producers and consumers of a closed session.

* + 1. The termination of a pending receive on close

JMS 1.0.1 did not describe how a pending message receive is terminated if its session or connection is closed. It is now specified that in this case receive returns a null message.

* + 1. Incorrect entry in Stream and Map Message conversion table

This table erroneously included a required conversion between char and String. This has been removed.

* + 1. Inactive durable subscription

A note explaining that an inactive durable subscription is one that exists but does not at the time have a TopicSubscriber created for it.

* + 1. Read-only message body

The read-only semantics of received message bodies was documented in the Message javadoc but was not included in the spec. It has been added.

* + 1. Changing header fields of a received message

When a message is received, its header field values may be changed; however, its property entries and its body are read-only. A note clarifying this has been added.

* + 1. Null/missing message properties and message fields

The result of accessing a null/missing value as a Java primitive type was previously not fully specified. This has clarified.

* + 1. JMS source errata

Two methods required by the spec were left out of the source, the getJMSXPropertyNames method of ConnectionMetaData and the getExceptionListener method of Connection. These have been added.

The type of the time-to-live parameter of setTimeToLive and getTimeToLive methods of MessageProducer and the type of the default time-to-live constant were int and have been changed to long.

The close sequence of TopicRequestor and QueueRequestor did not agree with the order specified in the specification and this has been corrected.

The type of the parameter of the createTextMessage method that takes an input value was changed from StringBuffer to String.

The subscription name parameter was missing from the createDurableSubscription method of TopicConnection. It has been added.

* + 1. JMS source Java API documentation errata

The correct end-of-message indicator for the readBytes method of BytesMessage is a return value of -1.

The setPriority method of MessageProducer should have a parameter named priority not deliveryMode.

* + 1. JMS source Java API documentation clarifications

Note that byte values are returned as byte[] not Byte[] by the readObject method of StreamMessage and the getObject method of MapMessage.

Note that the acknowledge method of Message acknowledges all messages received on that message’s session.

Note that the InvalidClientIDException is used for any client id value that a JMS provider considers invalid. Since client id value is JMS provider specific the criteria for determining a valid value is provider specific.

A note has been added to the readBytes method of StreamMessage and BytesMessage to describe how values that overflow the size of the input buffer are handled.

A note has been added that clarifies when setClientID method of Connection should be used.

Note that calling the setMessageListener method of MessageConsumer with a null value is equivalent to unsetting the MessageListener.

Note that the unsubscribe method of TopicSession should not be called to delete a durable subscription if there is a TopicConsumer currently consuming it.

Note that result of calling the setMessageListener method of MessageConsumer while messages are being consumed by an existing listener or the consumer is being used to synchronously consume messages is undefined.

Note the createTopic method of TopicSession and the createQueue method of QueueSession are used for converting a JMS provider specific name into a Topic or Queue object that represents an existing topic or queue by that name. These methods are not for creating the physical topic or queue. The physical creation of topics and queues are administrative tasks and are not done by JMS. The one exception is the creation of temporary topics and queues which is done using the createTemporaryTopic and createTemporaryQueue methods.

Note that the setObject method of ObjectMessage places a copy of the input object in a message.

Note that a connection is created in stopped mode and, for incoming messages to be delivered to the message listeners of its sessions, its start method must be called.

Documentation of Message default constants has been added.

Note the result of readBytes method of StreamMessage when the caller’s byte[] buffer is smaller than the byte[] field value being read.

The documentation of QueueRequestor and TopicRequestor has been improved.

The IllegalStateException has been noted as a required exception for several more error conditions. They are: acknowledging a message received from a closed session; attempting to call the recover method of a transacted session; attempting to call any method of a closed connection, session, consumer or producer (with the exception of the close method itself); attempting to set a connection’s client identifier at the wrong time or when it has been administratively configured.

* 1. Version 1.0.2b

The objective of version 1.0.2b of the JMS API Specification and Java API documentation is to correct errata in the JMS 1.02 Specification and the JMS 1.0.2a Java API documentation that have been uncovered by implementors and users.

Version 1.0.2b incorporates two sets of errata, which are marked by change bars in the Specification:

* Major errata and clarifications approved by a Java Community ProcessSSM program Maintenance Review that closed June 25, 2001.
* Minor errata formerly listed on the JMS documentation web page.
  + 1. JMS API specification, version 1.0.2: errata and clarifications

The following errata and clarifications have been incorporated into the Specification. They are listed in the order in which they occur in the Specification.

* Section 3.4.7 "JMSRedelivered": Change first paragraph to clarify when a provider must set this header field.
* Section 3.5.9 "JMS defined properties": Correct return value of ConnectionMetaData.getJMSXPropertyNamesmethod.
* Section 3.8.1.1 "Message selector syntax": After the first sentence, add sentence about the interpretation of a message selector whose value is an empty string. In the third sub-bullet item under “Identifiers,” add ESCAPE to the list of prohibited identifiers. In the fourth sub-bullet item, add sentence about data types of property values, and move description of the value of nonexistent properties referenced in a selector from last bullet item to here. Add sub-bullet item clarifying that data type conversions do not apply to properties used in message selectors. In the first sub-bullet item under “Comparison Operators,” clarify the result of comparing non-like type values. At end of section, correct quotation marks in example.
* Section 3.10 "Changing the value of a received message": Add paragraph clarifying the semantics of redelivering a message that was modified after being received.
* Section 3.12 "Provider implementations of JMS message interfaces": Insert paragraph clarifying the handling of destinations for foreign message implementations.
* Section 4.4.12 "Duplicate delivery of messages" (formerly misnumbered 4.4.14): Add sentence about JMSRedeliveredmessage header field.
* Section 4.5.2 "Asynchronous delivery": Clarify explanation of redelivery for AUTO\_ACKNOWLEDGE and DUPS\_OK\_ACKNOWLEDGE acknowledgment modes.
* Section 4.10 "Reliability": Clarify meaning of PERSISTENT and NON\_PERSISTENT delivery modes throughout section.
* Section 6.9 "TopicSession": Clarify redelivery of messages for durable and nondurable subscriptions.

Rationale for this change: The scope of redelivery is the lifetime of a destination, not of the session that is consuming it. Each nondurable subscription is a different destination, and its lifetime is the session that creates it. Each temporary queue or topic is a different destination whose lifetime is the connection that creates it.

* Section 6.12 "Recovery and redelivery": Clarify recoverability of messages for nondurable subscriptions.

Rationale for this change: Update the Specification to meet the expectation that a nondurable subscriber performs the same as a durable subscriber as long as the nondurable subscriber is in existence. The original statement in the specification could be interpreted to mean that message recovery was optional for a nondurable subscriber. It would be valuable to have a lower quality of service that did not require acknowledgement overhead, but a new mechanism should be provided to specify the lower quality of service option; the minimum quality of service required by the current specification should not be lowered.

* Section 7.3 "Standard exceptions": In description of IllegalStateException, change “should” to “must”. In description of MessageFormatException, correct method names, and change “should” to “must” in last sentence.
  + 1. JMS API Java API documentation, version 1.0.2a: major errata

The following items represent significant clarifications of the JMS API Java API documentation, version 1.0.2a. They are categorized as follows:

* Corrections of mistakes
* Reconciliations between the Specification and the Java API documentation

Less important clarifications to the Java API documentation are listed in Section B.3.3 "JMS API Java API documentation, version 1.0.2a: lesser errata"JMS API Java API documentation, version 1.0.2a: lesser errata.

* + - 1. Corrections of mistakes

In the following cases, the Java API documentation was in error and has been corrected:

* BytesMessageand StreamMessageinterfaces: Correct discussion of modification of sent messages.
* TemporaryQueue.deleteand TemporaryTopic.deletemethods: Remove references to senders and publishers.
  + - 1. Reconciliations between the specification and the Java API documentation

The following items update the Java API documentation to match the correct language in the Specification:

* Messageinterface: Correct description of getting values for unset property names to match Section 3.5.4 "Property value conversion". Remove incorrect bullet items about NULL values in arithmetic operations and BETWEEN operations.
* Message.acknowledgemethod: Clarify that the method applies to all consumed messages of the session.

Rationale for this change: A possible misinterpretation of the existing Java API documentation for Message.acknowledge assumed that only messages received prior to “this” message should be acknowledged. The updated Java API documentation statement emphasizes that message acknowledgement is really a session-level activity and that this message is only being used to identify the session in order to acknowledge all messages consumed by the session. The acknowledge method was placed in the message object only to enable easy access to acknowledgement capability within a message listener’s onMessage method. This change aligns the specification and Java API documentation to define Message.acknowledge in the same manner.

* Message.getJMSTimestampand MessageProducer.setDisableMessageTimestampmethods: Correct descriptions of effect of disabling timestamps.
* TopicSession.createSubscriberand TopicSession.createDurableSubscribermethods: Correct **Throws:** lists.
  + 1. JMS API Java API documentation, version 1.0.2a: lesser errata

The Java API documentation corrections listed in this section concern the application of logic from the Specification or elsewhere in the Java API documentation:

* Corrections to the Specification listed in Section B.3.1 "JMS API specification, version 1.0.2: errata and clarifications".
* Information in the Specification not previously reflected in the Java API documentation
* Information provided in some parts of the Java API documentation, but not in others where it also belongs.

Message interface: Add the corrections to Section "" to the section on message selectors.

Also change the Java API documentation for the following methods to reflect these changes:

QueueConnection.createConnectionConsumer

QueueSession.createReceiver

QueueSession.createBrowser

TopicConnection.createConnectionConsumer

TopicConnection.createDurableConnectionConsumer

TopicSession.createSubscriber

TopicSession.createDurableSubscriber

QueueBrowser.getMessageSelector

MessageConsumer.getMessageSelector

Correct the Java API documentation for the following methods to add *InvalidDestinationException* to the **Throws:** list, in accordance with Section 7.3 "Standard exceptions":

QueueConnection.createConnectionConsumer

QueueRequestor.QueueRequestor

TopicConnection.createConnectionConsumer

TopicConnection.createDurableConnectionConsumer

TopicRequestor.TopicRequestor

TopicSession.createDurableSubscribermethod: Change the description of the two-argument form to accord with the description of the one-argument form of the *TopicSession.createSubscriber* method.

QueueSenderand TopicPublisherinterfaces: Add clarifications from Section 3.9 "Access to sent messages" and Section 3.4.11 "How message header values are set". Add UnsupportedOperationExceptionto sendand publishmethod **Throws:** lists where relevant*.*

QueueReceiverinterface: Add language from Section 5.8 "QueueReceiver".

IllegalStateExceptionand MessageFormatExceptionclasses: Add corrections from Section 7.3 "Standard exceptions".

* 1. Version 1.1

This section describes the changes to the JMS specification for version 1.1. The changes include API unification of messaging domains, specification clarifications, and several additional methods.

* + 1. Unification of messaging domains

This maintenance release addresses the unification of the programming interfaces for the point-to-point and pub/sub messaging domains in the Java Message Service (JMS) API. In the 1.0.2b version of the JMS specification, the client programming model made a strong distinction between these two domains. One consequence of domain separation is that actions from the point-to-point domain and the pub/sub domain could not be used in the same transaction.

In this version of the interfaces, methods have been added to support the ability to include PTP and pub/sub messaging in the same transaction. In addition, domain unification simplifies the client programming model, so that the client programmer can use a simplified set of APIs to create an application.

The scope of a transaction in JMS is on a per Sessionbasis. To add the ability to work across both domains, a number of methods have been added the javax.jms.Sessioninterface. Adding these methods supports the creation of javax.jms.MessageConsumer and javax.jms.MessageProducerobjectsfor either domain at the Sessionlevel, and supports sending and receiving message using either domain within the same Session.

For example, using these proposed methods, a JMS client can create a transacted session, and then receive messages from a queueand send messages to a topicwithin the same transaction. In JMS 1.0.2b, this was not possible.

At the same time, the semantic differences between the two domains are retained. While it is possible to support actions on PTP and pub/sub destinations within the same session, the semantic differences that cause different behaviors within those domains are retained.

* + 1. JMS API specification, version 1.1: domain unification

The following is a list of changes that were added to the JMS specification to describe the requirements related to domain unification. They are listed in the order in which they appear in the specification.

* Section 1.2.3.3 "JMS domains" describes the backward compatibility relationship between earlier versions of the JMS specification and version 1.1 of the JMS specification.
* Section 2.4 "Two messaging styles" and Section 2.5 "JMS interfaces" add information about the two message domains, and a table that describes the relationship between the JMS common interfaces and the domain-specific interfaces that are derived from the JMS common interfaces.
* Section 4.4 "Session" updates the list of the activities that can be performed in a Sessionto include that it a Sessionis a factory for MessageProducerand MessageConsumer objects, and is a factory for TemporaryTopicand TemporaryQueue objects.
* Section 4.5 "MessageConsumer" adds that a MessageConsumercan be created from a Session.
* Section 4.11 "Method inheritance across messaging domains" is a new section that describes how to handle methods that are not appropriate to a specific messaging domain.
* Section 5.1 "Overview" adds a table that describes the relationship between the JMS common interfaces and the domain-specific interfaces that are derived from the JMS common interfaces.
* Section 5.4 "TemporaryQueue" adds that the lifespan of the TemporaryQueueis the life of the Connectionor QueueConnectionthat creates it. Previously, only QueueConnectionwas mentioned, but TemporaryQueues can now be created from Connections.
* Section 5.9 "QueueBrowser" adds that a QueueBrowsercan be created from Session, as well as from the QueueSession.
* Section 6.1 "Overview" adds a table that describes the relationship between the JMS common interfaces and the domain-specific interfaces that are derived from the JMS common interfaces.
* Section 6.6 "TemporaryTopic" adds that the lifespan of the TemporaryTopicis the life of the Connectionor TopicConnectionthat creates it. Previously, only TopicConnectionwas mentioned, but a TemporaryTopiccan now be created from a Connection*.*
* Section 6.10 "TopicPublisher" adds a comment that messages can be sent to a topic either using a TopicPublisheror a MessageProducer.
* Section 6.11.1 "Durable " adds that durable TopicSubscriberscan be created either relative to a TopicConnectionor a Connection. The unsubscribemethod for the durable Topic subscription can also be used either at the *TopicConnection* or *Connection* level.
* Section 8.6 "JMS application server interfaces" adds a table that shows the relationships between the JMS common interfaces and the domain-specific interfaces that are derived from the JMS common interfaces.
* Chapter 9 "JMS example code" has been rewritten to reflect the use of the JMS common interfaces. It now uses the new methods associated with domain unification.
  + 1. JMS API specification, version 1.1: updates and clarifications

The following are additional updates to the JMS specification. They include both updated material, and clarifications of existing material. They are listed in the order in which they appear in the specification.

* + - 1. Updates to introduction, added figures

These changes reflect new information about how the JMS API relates to other technologies, and what’s new in this version of the specification. It also reflects the addition some diagrams to assist in the reading of the specification.

* Section 1.4 "Relationship to other Java APIs" is updated with the current status of the relationship of the JMS specification to the JDBC API, the EJB API, and the JTA API.
* Section 1.4 "Relationship to other Java APIs" has two new sections: Section 1.4.7 "Java Platform, Enterprise Edition (Java EE) " and section 1.4.8 "Integration of JMS with the EJB Components" [which has subsequently been deleted in JMS 2.0]. These new sections describe how JMS relates to the J2EE platform.
* Section 1.5 "What is new in JMS 1.1?" is a new section that summarizes the changes in this maintenance release.
* Section 2.3 "Administration" contains a new figure which illustrates the relationship between the Administered objects and other elements of the JMS system.
* Section 2.5 "JMS interfaces" adds a figure which illustrates the relationships among the basic JMS elements.
  + - 1. Clarifications
* Section 3.8.1.1 "Message selector syntax" clarifies when semantic checking may occur. At the end of that section, there is a requirement that JMS providers must check syntactic correctness at the time that a message selector is presented. This statement has been updated to note that JMS providers are also permitted to check semantic correctness at that time, although not all semantic correctness can be verified at that time.
* Section 4.3.8 "ExceptionListener" adds a clarification that if no ExceptionListeneris registered, the getExceptionListenermethod should return null.
* Section 4.4.6 "Conventions for using a session" adds a clarification that use of the JTS aware interfaces described in Chapter 8 are not intended for use in the client JMS program. Use of these interfaces may create nonportable software, as the JTS aware interfaces described in Chapter 8 are optional.
* Section 4.4.9 "Multiple sessions" adds a further clarification that the JMS specification does not assign a semantic meaning to multiple QueueReceivers consuming from one Queue.
* Section 6.12 "Recovery and redelivery" adds an additional clarification that setting the delivery mode to PERSISTENT will not change the delivery model for messages sent to a non durable subscriber. This is already described in section 6.15 "Reliability".
* Section 8.1 "Overview" adds a clarification that JMS client program use of the JTS aware interfaces described in Chapter 8 may create non-portable code.
  + 1. JMS API Java API documentation, version 1.1: domain unification

In order to support domain unification a number of existing interfaces were updated with additional methods.Table 11-1 lists the interfaces that were changed, and the new methods for those interfaces.

Table 11.1 New JMS API methods for domain unification

| Interface | New Methods |
| --- | --- |
| **Connection** | ConnectionConsumer **createConnectionConsumer**  (Destination destination, String  messageSelector, ServerSessionPool  sessionPool, int maxMessages)  throws JMSException; |
| ConnectionConsumer  **createDurableConnectionConsumer**(Topic  topic,String subscriptionName, String  messageSelector, ServerSessionPool  sessionPool, int maxMessages)  throws JMSException; |
| **ConnectionFactory** | Connection **createConnection**()  throws JMSException; |
| Connection **createConnection**(String userName,  String password) throws JMSException; |
| **MessageProducer** | Destination **getDestination**()  throws JMSException; |
| void **send**(Message message)  throws JMSException; |
| void **send**(Message message, int deliveryMode,  int priority, long timeToLive)  throws JMSException; |
| void **send**(Destination destination, Message  message) throws JMSException; |
| **Session** | MessageProducer **createProducer** (Destination  destination) throws JMSException; |
| MessageConsumer **createConsumer** (Destination  destination) throws JMSException; |
| MessageConsumer **createConsumer** (Destination  destination, java.lang.String  messageSelector) throws JMSException; |
| MessageConsumer **createConsumer** (Destination  destination, java.lang.String  messageSelector, boolean NoLocal)  throws JMSException; |
| TopicSubscriber **createDurableSubscriber**  (Topic topic, java.lang.String name)  throws JMSException; |
| **Session** | TopicSubscriber **createDurableSubscriber**(  Topic topic, java.lang.String name,  java.lang.String messageSelector,  boolean noLocal) throws JMSException; |
| QueueBrowser **createBrowser**(Queue queue)  throws JMSException; |
| QueueBrowser **createBrowser**(Queue queue,  String messageSelector)  throws JMSException; |
| Queue **createQueue** (String name)  throws JMSException; |
| Topic **createTopic** (String name)  throws JMSException; |
| TemporaryTopic **createTemporaryTopic**()  throws JMSException; |
| TemporaryQueue **createTemporaryQueue**()  throws JMSException; |
| void **unsubscribe**(String string name); |
| **XAConnection** | XASession **createXASession**()  throws JMSException; |
| **XAConnectionFactory** | XAConnection **createXAConnection**()  throws JMSException; |
| XAConnection **createXAConnection**(  String userName, String password)  throws JMSException; |
| **XASession** | Session **getSession**() throws JMSException; |

In addition, explanatory material was added to describe the relationship between the new methods and existing interfaces and methods. The interfaces that have been changed to describe these relationships are:

Queue

QueueBrowser

QueueConnection

QueueConnectionFactory

QueueReceiver

QueueSender

QueueSession

Session

TemporaryQueue

TemporaryTopic

Topic

TopicConnection

TopicConnectionFactory

TopicPublisher

TopicSubscriber

TopicSession

* + 1. JMS API documentation, version 1.1: changes

The Java API documentation also includes updates that reflect new features or additional clarifications.

* + - 1. New methods

BytesMessage.getBodyLength

long getBodyLength() throws JMSException

This method permits the programmer to determine the size of the BytesMessagebody and, if necessary, allocate a bytes array to copy the body.

Session.getAckowledgeMode

int getAcknowledgeMode() throws JMSException

This method returns the currently set value of how a Sessionacknowledges messages. This method is added for completeness, because in previous versions of the specification there was no way to get this value.

* + - 1. Clarifications

Connection.getExceptionListener

If Connection.getExceptionListener is called, and no ExceptionListeneris registered, the JMS provider must return null. A client program may optionally associate an ExceptionListenerwith a Connection. If no ExceptionListeneris associated with the ConnectionListener, null should be returned. Previously, the Java API documentation did not specify what the return value should be.

MapMessage

A clarification to the set methods of MapMessage*,* stating if the name parameter is null or an empty string, the method must throw the error InvalidArgumentException.

The rationale is that each of the named elements in the MapMessage should have names that are not null or blank.

Methods affected:

MapMessage.setBoolean

MapMessage.setByte

MapMessage.setBytes

MapMessage.setChar

MapMessage.setDouble

MapMessage.setFloat

MapMessage.setInt

MapMessage.setLong

MapMessage.setObject

MapMessage.setShort

MapMessage.setString

Message

A clarification to the set property methods of Messagestates if the property name parameter is null or empty string, the method must throw the error InvalidArgumentException.

The rationale is that each of the properties in the Messageshould have names that are not null or blank.

Methods affected:

Message.setBooleanProperty

Message.setByteProperty

Message.setDoubleProperty

Message.setFloatProperty

Message.setIntProperty

Message.setLongProperty

Message.setObjectProperty

Message.setShortProperty

Message.setStringProperty

TextMessage

A comment in the description for TextMessagethat indicated that XML might become popular has been changed to state that TextMessagecan be used to send XML messages.

XA interfaces

The descriptions of the XA interfaces now state that those interfaces are primarily used by JMS providers, and are optional; that is, the JMS provider is not required to support them. Use of the XA interfaces by a client program may lead to non-portable code.

Interfaces affected:

XAConnection

XAConnectionFactory

XAQueueConnection

XAQueueConnectionFactory

XAQueueSession

XASession

XATopicConnection

XATopicConnectionFactory

XATopicSession

The descriptions of QueueSession*,* TopicSession*,* and QueueConnectionnow list methods that must not be called through these interfaces. These methods are a result of inheritance, but are not appropriate to be called from domain-specific interfaces. These are also described in Section 4.11 "Method inheritance across messaging domains". If they are invoked, an IllegalStateException must be thrown.

Table 11.2 Domain dependent interfaces

| **Interface** | **Method** |
| --- | --- |
| QueueConnection | createDurableConnectionConsumer |
| QueueSession | createDurableSubscriber |
| createTemporaryTopic |
| createTopic |
| unsubscribe |
| TopicSession | createQueueBrowser |
| createQueue |
| createTemporaryQueue |

* 1. Version 2.0

All changes made for JMS 2.0 are represented by individual issues in the JMS specification issue tracker at <http://http://java.net/jira/browse/JMS_SPEC>. The appropriate issue number (e.g. JMS\_SPEC-64) is given for each change below.

* + 1. Re-ordering of chapters

Chapter 10 "Issues" and chapter 11 "Change history" have become appendices A and B and moved to the end of the specification.

New chapters 10 "Use of JMS API in Java EE applications" and 11 "Simplified JMS API" have been added.

* + 1. JMS providers must implement both P2P and Pub-Sub (JMS\_SPEC-50)

The specification has been amended to state that a JMS provider must implement both point-to-point messaging (queues) and publish-subscribe messaging (topics). This was already required by the Java EE 6 specification, section EE.2.7, but was not previously required by the JMS specification itself.

Section 1.3 "What is required by JMS" has therefore been updated to delete the sentence that states " Providers of JMS point-to-point functionality are not required to provide publish/subscribe functionality and vice versa".

* + 1. Use of JMS API in Java EE applications (JMS\_SPEC-45 and JMS\_SPEC-27)

A new chapter 10 "Use of JMS API in Java EE applications" has been added. This chapter incorporates and clarifies various additional requirements which were previously only described in the Java EE and EJB specifications. Section 10.2 "Restrictions on the use of JMS API in the Java EE web or EJB container" includes a list of methods which may not be used in a Java EE web or EJB container and section 10.3 "Behaviour of JMS sessions in the Java EE web or EJB container" clarifies how the arguments to createSession are mostly ignored when used in a Java EE web or EJB container.

Section 1.4.7 "Java Platform, Enterprise Edition (Java EE)" has been updated to refer to Java EE 7 rather than J2EE 1.3. A reference has also been added to the new chapter 10 "Use of JMS API in Java EE applications".

Section 1.4.8 "Integration of JMS with the EJB components" has been deleted. It is superseded by the new chapter 10 "Use of JMS API in Java EE applications".

* + 1. New methods to create a session (JMS\_SPEC-45)

The Connection method createSession(boolean transacted, int acknowledgeMode) has sometimes been a cause of confusion because if the transacted argument is set to true then the acknowledgeMode argument is ignored but must still be given a value.

To simplify application code a new Connection method createSession(int sessionMode) has been added which provides the same functionality as the previous method but with a single argument.

Examples 9.1.4 "Creating a Session" and 9.3.3.1 "Creating a durable subscription" have been updated to use this new method.

In addition, a second new Connection method createSession() has been added. This has no arguments and is intended for use in a Java EE web or EJB container in the case when there is an active JTA transaction, when the sessionMode supplied to createSession(int sessionMode) is ignored.

* + 1. Multiple consumers now allowed on the same topic subscription (JMS\_SPEC-40)

In JMS 1.1, a durable or non-durable topic subscription was not permitted to have more than one consumer at a time. This meant that the work of processing messages on a subscription could not be shared amongst multiple threads, connections or JVMs, thereby limiting scalability. This restriction has therefore been removed in JMS 2.0.

For durable subscriptions, no changes have been made to the JMS API other than removing this restriction from the createDurableSubscriber methods on Session and the new createDurableConsumer methods on Session and JMSContext. Section 6.11.3 "Durable subscriptions" has been updated accordingly.

For non-durable subscriptions, a new distinction is introduced between an unshared and a shared non-durable subscription.

The existing createConsumer and createSubscriber methods on Session and the createConsumer methods on JMSContext remain unchanged and are used to create what is now called an unshared non-durable subscription. A new section 6.11.1 "Unshared non-durable subscriptions" has been added.

New createSharedConsumer methods have been added on Session and JMSContext. These create a shared non-durable subscription and allow a name to be specified to identify the subscription. A new section 6.11.2 "Shared non-durable subscriptions" has been added.

* + 1. Delivery delay (JMS\_SPEC-44)

A new feature "delivery delay" has been added which allows a producing client to specify the earliest time when a provider may make the message visible on the target destination and available for delivery to consumers.

A new section 4.13 "Delivery delay" and a corresponding new section 3.4.13 "JMSDeliveryTime" have been added to describe this new feature. Section 4.4.10.2 "Order of message sends" has been updated to state that messages with a later delivery time may be delivered after messages with an earlier delivery time.

Section 4.4.11 "Message acknowledgment" has been updated to state that when a session's recover method is called the messages it now delivers may be different from those that were originallydelivered due to the delivery of messages which could not previously be delivered as they had not reached their specified delivery time.

Section 4.6 "MessageProducer" has been updated to mention that a client may now define a default delivery delay for messages sent by a producer.

* + 1. Sending messages asynchronously (JMS\_SPEC-43)

New send methods have been added to MessageProducer which allow messages to be sent asynchronously. These methods return immediately and perform the send in a separate thread without blocking the calling thread. When the send is complete, a callback method is invoked on an object supplied by the caller. Similar methods are available on the new JMSContext interface.

Section 4.6 "MessageProducer" has been extended to describe these additional send methods..

* + 1. Use of AutoCloseable (JMS\_SPEC-53)

The Connection, Session, MessageProducer, MessageConsumer and QueueBrowser interfaces have been modified to extend the java.lang.Autocloseable interface. This means that applications can create these objects using a Java SE 7 try-with-resources statement which removes the need for applications to explicitly call close() when these objects are no longer required.

The new JMSContext and JMSConsumer interfaces also extend the java.lang.Autocloseable interface.

Ssections 4.3.5 "Closing a Connection" and 4.4.1 "Closing a Session" and the new section 11.2.6 "Closing the JMSContext" all explain that the use of a try-with-resources statement makes it easier to ensure that these objects are closed after use.

The example in section 9.1.3 "Creating a Connection" has been extended to add a second example which uses the the try-with-resources statement.

* + 1. JMSXDeliveryCount (JMS\_SPEC-42)

The existing message property JMSXDeliveryCount has been made mandatory. It was previously optional. This means that JMS providers must set this property when a message is delivered to the number of times the message has been delivered.

A new section 3.5.11 "JMSXDeliveryCount" has been added which describes this property and explains how it is not required to be guaranteed in all possible cases, such as after a server failure.

Section 3.5.9 "JMS defined properties" has been updated accordingly. Some of the wording in this section has been rearranged to reflect the fact that some properties are optional but that one (JMSXDeliveryCount) is now mandatory. A clarification has been added to state that the effect of setting a message selector on a property (such as JMSXDeliveryCount) which is set by the provider on receive is undefined.

Section 3.4.7 "JMSRedelivered" has been amended to mention the JMSXDeliveryCount property as well.

Section 4.4.11 "Message acknowledgment": A sentence which mentions the JMSRedelivered flag has been amended to mention the JMSXDeliveryCount property as well.

4.4.12 "Duplicate delivery of messages": A sentence which mentions the JMSRedelivered flag has been amended to mention the JMSXDeliveryCount property as well..

4.5.2 "Asynchronous delivery": A sentence which mentions the JMSRedelivered flag has been amended to mention the JMSXDeliveryCount property as well.

4.10 "Reliability": A sentence which mentions the JMSRedelivered flag has been amended to mention the JMSXDeliveryCount property as well.

* + 1. Client ID optional on Durable subscriptions (JMS\_SPEC-39)

It is no longer mandatory for the client identifier to be set when creating or activating a durable subscription.

The javadocs for the various methods which create a durable subscription have updated to reflect this change and rewritten to improve clarify.

In addition the following sections have been updated:

Section 4.3.2 "Client identifier" has been changed to state that its use in identifying a durable subscription is optional.

Section 6.3 "Durable subscription" has been amended by adding a cross-reference to Section 6.11.1 "Durable " at the end.

Section 6.11.1 "Durable subscriptions" has been completely rewritten. This section was essentially a copy of the javadoc comment on the createDurableSubscriber methods and since those javadoc comments have been rewritten to make them clearer this section has been rewritten as well. The only substantive change is to state that the use of client identifier in identifying a durable subscription is optional. Cross-references to Section 6.3 "Durable subscription" and Section 4.3.2 "Client identifier" have been added at the end.

* + 1. New createDurableConsumer methods (JMS\_SPEC-51)

The Session interface has been extended to add two createDurableConsumer methods which return a MessageConsumer.

These are intended to replace the existing createDurableSubscription methods which return a TopicSubscriber. A TopicSubscriber is a domain-specific interface whose use has been discouraged since the domain-independent interfaces were introduced in JMS 1.1.

Section 6.11.1 "Durable " has been updated to reflect this.

* + 1. Simplified API (JMS\_SPEC-64)

Three new objects JMSContext, JMSProducer and JMSConsumer have been added which together combine the functionality of the existing Connection, Session , MessageProducer and MessageConsumer objects. This provides an alternative API for using JMS which is referred to in this specification as the "simplified API".

JMSContext objects may be created using new methods on ConnectionFactory. Java EE applications may alternatively create JMSContext objects using injection.

The goals of the simplified API are described in 11.1 "Goals of the simplified API" and a summary of the API is given in section 11.2 "Key features of the simplified API".

Developers now have a choice as to whether to use the "standard API" (the Connection, Session, MessageProducer and MessageConsumer objects) or the "simplified API" (the JMSContext, JMSProducer and JMSConsumer objects).

The two APIs are intended to offer identical functionality. The standard API is not deprecated and will remain part of JMS indefinitely.

Section 11.4 "Examples using the simplified API" contains a number of examples which compare the use of the simplified and standard APIs in a number of simple Java EE and Java SE use cases.

* + 1. New method to extract the body directly from a Message (JMS\_SPEC-101)

Two new methods have been added to Message:

* <T> T getBody(Class<T> c)
* boolean isBodyAssignableTo(Class c)

The getBody method returns the message body as an object of the specified type. This provides a convenient way to obtain the body from a newly-received Message object. It can be used either

* 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, or
* to 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 is a companion method which 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.

* + 1. Clarification: message may be sent using any session (JMS\_SPEC-52)

The specification and javadocs have been clarified to make it clear that a message may be sent using any session, not just the session used to create the message.

Section 4.4.5 "Optimized message implementations" has been updated accordingly.

* + 1. Clarification: use of ExceptionListener (JMS\_SPEC-49)

Section 4.3.8 "ExceptionListener" has been amended to clarify how an ExceptionListener is used:

* The existing text which states that a connection "serializes execution of its ExceptionListener" has been extended to explain what this means.
* A note has been added to state that there are no restrictions on the use of the JMS API by the listener's onException method.

In addition, the following changes to javadoc comments have been made:

* The javadoc comments for the stop and close methods on the Connection interface have been amended to clarify that, if an exception listener for the connection is running when stop or close are invoked, there is no requirement for the stop or close call to wait until the exception listener has returned before it may return.
* Similarly, the javadoc comment for the close method on the Session interface has been amended to clarify that, if an exception listener for the session's connection is running when close is invoked, there is no requirement for the close call to wait until the exception listener has returned before it may return.
* The javadoc comments for the stop and close methods on the JMSContext interface have been amended to clarify that, if an exception listener for the JMSContext's connection is running when stop or close are invoked, there is no requirement for the stop or close call to wait until the exception listener has returned before it may return.
  + 1. Clarification: use of stop or close from a message listener (JMS\_SPEC-48)

The specification has been clarified to state that a message listener must not call its own connection's stop or close methods, or its own session's stop method. This is because the specification requires that these methods should not return until any message listeners have returned and so calling them from a message listener would lead to deadlock.

A new requirement has been added that the JMS provider throw a javax.jms.IllegalStateException in such cases.

The following sections have been updated accordingly:

* Section 4.3.4 "Pausing delivery of incoming messages"
* Section 4.3.5 "Closing a Connection"
* Section 4.4.1 "Closing a Session"

The following javadoc comments have been updated accordingly:

* The Connection method stop
* The Connection method close
* The Session method close
* The JMSContext method stop
* The JMSContext method close
  + 1. Clarification: use of noLocal when creating a durable subscription (JMS\_SPEC-65)

The specification has been amended to clarify the effect of setting the noLocal argument when creating a durable subscription. This was poorly defined in JMS 1.1.

In addition, the definition of noLocal has been extended to cover the case added in JMS 2.0 and described in section B.5.5 where a durable subscription has more than one active consumer

The new definition of noLocal is given in section 6.11.3 "Durable subscriptions". This states that when a durable subscription is created on a topic, the noLocal argument may be used to specify that messages published to the topic by its own connection or any other with the same client identifier will not be added to the durable subscription. It also states that if the client identifier is unset then setting noLocal to true will cause an exception to be thrown.

* + 1. Clarification: message headers that are intended to be set by the JMS provder (JMS\_SPEC-34)

The specification has been clarified to state that the following methods on Message are not for use by client applications and setting them does not have any effect:

setJMSDeliveryMode, setJMSExpiration, setJMSPriority, setJMSMessageID, setJMSTimestamp, setJMSRedelivered, setJMSDeliveryTime (new header property: see section B.5.6).

Section 3.4.11 "How message header values are set" has been extended to explain this.

* + 1. Clarification: Session methods createQueue and createTopic (JMS\_SPEC-31)

The javadoc comments for the createQueue and createTopic methods on Session and JMSContext have been reworded to clarify that these methods simply create a Queue or Topic object which encapsulates the name of the queue or topic and do not create the physical queue or topic in the JMS provider.

In addition a note has been added to these javadoc comments to explain that although creating a physical queue or topic is provider-specific and is typically an administrative task performed by an administrator, some providers may create them automatically when needed.

* + 1. Clarification: Definition of JMSExpiration (JMS\_SPEC-82)

In the JMS 1.1 specification, section 3.4.9 "JMSExpiration", a message's expiration time was defined as "the sum of the time-to-live value specified on the send method and the current GMT value".

However the JMSExpiration header field is a long value and the specification does not define how the expiration time is converted to a long.

This has now been clarified to state that it is "the difference, measured in milliseconds, between the expiration time and midnight, January 1, 1970 UTC." This definition is chosen to be consistent with the java.lang.System method currentTimeMillis.

The updated text can be seen in section 3.4.9 "JMSExpiration" and section 4.8 "Message time-to-live".

* + 1. Correction: Reconnecting to a durable subscription (JMS\_SPEC-80)

In the JMS 1.1 specification, section 9.3.3.2 "Reconnect to a topic using a durable subscription" stated that "the client must be attached to the same Connection". This was incorrect and has now been corrected to state that the client must use a connection with the same client identifier.

In addition this section has been renamed 9.3.3.2 "Creating a consumer on an existing durable subscription" and rewritten to make it clearer.

* + 1. Correction: MapMessage when name is null (JMS\_SPEC-77)

In the JMS 1.1 API documentation for javax.jms.MapMessage, the method setBytes (String name, byte[] value) is defined as throwing a NullPointerException "if the name is null, or if the name is an empty string."

However there are eleven other methods on MapMessage of the form setSomething(name,value). These all specify that a IllegalArgumentException is thrown "if the name is null or if the name is an empty string."

This appears to be an error in the API documentation. This is confirmed by the JMS compliance tests which already expect setBytes to throw a IllegalArgumentException.

The API documentation for setBytes has therefore been changed to match the other methods and specify that an IllegalArgumentException should be thrown in this case.

1. Their implementation of setJMSCorrelationIDAsBytes() and getJMSCorrelationIDAsBytes() may throw java.lang.UnsupportedOperationException. [↑](#footnote-ref-1)
2. See X/Open CAE Specification Data Management: Structured Query Language (SQL), Version 2, ISBN: 1-85912-151-9 March 1996. [↑](#footnote-ref-2)
3. The Java Tutorials may be found at <http://docs.oracle.com/javase/tutorial/index.html>. [↑](#footnote-ref-3)
4. The term ‘transacted session’ refers to the case where a session’s commit and rollback methods are used to demarcate a transaction local to the session. In the case where a session’s work is coordinated by an external transaction manager, a session’s commit and rollback methods are not used and the result of a closed session’s work is determined later by the transaction manager. [↑](#footnote-ref-4)
5. There are no restrictions on the number of threads that can use a Session object or those it creates. The restriction is that the resources of a Session should not be used concurrently by multiple threads. It is up to the user to ensure that this concurrency restriction is met. The simplest way to do this is to use one thread. In the case of asynchronous delivery, use one thread for setup in stopped mode and then start asynchronous delivery. In more complex cases the user must provide explicit synchronization. [↑](#footnote-ref-5)