Using IBM WebSphere Application Server and IBM WebSphere MQ Together

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Session 15017
Agenda

- Connecting WebSphere Application Server to the WebSphere MQ messaging Infrastructure
- Configuring the environment for JMS outbound messaging
- Inbound messaging
- Features of WebSphere MQ Resource Adapter
- Common 'Gotchas'
- Reference links
How do we interact with our messaging infrastructure?
Use the most appropriate protocol

WebSphere Application Server is a fully compliant Java Enterprise Edition (JEE) application server. The Java Message Service (JMS) is the JEE application messaging protocol. Therefore, JMS is the answer!

WebSphere MQ provides a fully JMS 1.1 compliant messaging provider.

Therefore, JMS is the answer!
Java Message Service (JMS)

- A standardised Java API which allows applications to utilise messaging.

- JMS makes use of administered objects to keep the application abstracted away from the messaging provider's configuration specifics.

This also permits the configuration to be changed without recompiling the application.

- Supports both point-to-point messaging, and publish/subscribe.

- Applications are unaware of the implementation details. **JMS is not a wire protocol.**
JEE compliant application servers must provide support for JMS.

A WebSphere MQ server is not included within the WAS installation, so (from WAS v7.0 onwards) WAS includes an alternative JMS messaging provider, the:

Service Integration Bus (SIB)

This is referred to as the “Default Messaging Provider” within the Administration Console.

In addition to SIB, a WAS installation also comes with an integrated WebSphere MQ Resource Adapter (WMQ-RA), which provides JMS messaging functionality which uses the capabilities of WebSphere MQ.
From WAS v7.0 onwards, the WebSphere MQ Resource Adapter (WMQ-RA) is now supplied with the WAS installation*, and updated by the application of WAS fix packs.

Therefore each version of WAS is associated with a specific version of the WMQ-RA. This is detailed on a web page (see link above).

This does not limit the version of the queue manager you are using!

Do not bundle the WMQ classes for Java/JMS .jar files within your applications.

* A Liberty profile in WAS 8.5.5 does not include the WMQ-RA – and this must be manually added for WMQ-JMS function. This is downloaded from: http://www.ibm.com/support/docview.wss?uid=swg21633761
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JMS 1.1 Overview

The ConnectionFactory is used to construct JMS Connection objects, which provides a communication mechanism with the messaging provider.

The JMS Session is constructed from the Connection. The Session encapsulates the transactional units of work when performing operations with the messaging provider.

The MessageProducer and MessageConsumer provide message sending and receiving function. The JMSMessage class contains the user and meta data which is sent or received from the messaging provider.

The JMS Destination holds the configuration of the queues or topics on the messaging provider that the MessageProducer and MessageConsumer are sending or receiving messages from.

The ConnectionFactory and Destination objects contain provider specific configuration data. *This is a problem if we want our JMS application to be provider agnostic.*
JNDI – Java Naming and Directory Interface

To maintain messaging provider independence, we lookup provider specific objects within a central store, called a JNDI.

The JNDI is used to store more than just the configuration of JMS objects, for objects associated with database lookups.

Example of use to obtain a ConnectionFactory definition from within an EJB:

```java
import javax.naming.Context;
import javax.naming.InitialContext;

... ...

Context jndiContext = new InitialContext();
ConnectionFactory myConnectionFactory =
    (ConnectionFactory)jndiContext.lookup("jms/myConnectionFactory");
```
Configuring for WebSphere MQ: Connection Factories

- Specifies how an application connects to a WMQ Queue Manager
- Requires:
  - Queue manager name
  - Transport type (client or bindings)
  - Hostname and port
  - Channel name
  - A JNDI name – how the object is referenced from within the EJB
- Optional configuration, such as SSL
- Alternatively you can use WMQ client channel definition table (CCDT) URL

**Connection factories** > MyCF
A unified JMS connection factory can be used to create JMS connections to both queue and topic destinations.

**General Properties**

**Administration**
- **Scope**
  - `Node=localhost,Node03,Server=server1` (default)
- **Provider**
  - WebSphere MQ messaging provider

- **Name**
  - MyCF (default)

- **JNDI name**
  - `jms/MyCF` (default)

**Description**

**Connection**

- **Queue manager**
  - MyQM (default)

- **Transport**
  - Bindings, then client

  - **Hostname**
    - `localhost`

  - **Port**
    - `1414`

  - **Connection name list**
    - `localhost(1414)`

  - **Server connection channel**
    - `SYSTEM.DEF.SVRCONN`
Configuring for WebSphere MQ: Destinations

Resources > JMS > Queues / Topics > [New]

Queue destinations provided for point-to-point messaging by the WebSphere MQ destinations for the WebSphere MQ messaging provider.

General Properties

Administration
- Scope
  Node=localhostNode03,Server=server1
- Provider
  WebSphere MQ messaging provider
- Name
  Q
- JNDI name
  jms/Q
- Description

WebSphere MQ Queue
- Queue name
  Q

Queues
- Identifies the actual queue in WMQ
  - Can be used to set properties such as persistence, priority, etc.

Topics
- Defines the WMQ publish/subscribe destination
Putting it all together – sending a message

**WebSphere Application Server**

**Administrative Store**
- Connection-Factory 'QMGR'
- Destination 'Q'

**EJB Application**
- JMS Connection
- JMS Session
- MessageProducer

**Queue Manager 'QMGR'**
- Queue 'Q'

**SHARE Technology - Connections - Results**
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Inbound Messaging

What we have looked at so far we term 'outbound messaging', meaning messaging which was initiated from an application.

This is typically used with Web Servlets for example, which are initiated from an external HTTP request to the application server.

A alternative we term 'inbound messaging', meaning a message on a WMQ queue triggers the running of an application code.

In the JEE world, these types of application are call Message Driven Beans (MDB).

They are configured using an 'Activation Specification' (JEE), or a Listener Port (WAS).
Activation Specifications are the standardised way of delivering messages to an MDB.

The WebSphere MQ Resource Adapter provides Activation Specification functionality when used with WebSphere MQ.

Listener Ports provide a similar function but are not part of the JEE standard, and are functionally stabilized within WAS.

Activation Specifications combine the configuration of connectivity, the JMS Destination where messages are to be consumed from, and the runtime characteristics of the MDB itself.

Activation Specifications can be defined at all WAS configuration scopes, as can be done for ConnectionFactories and Destinations.
Message Selectors are used when you only want messages with a set of specific properties to trigger the MDB. These properties can be user defined as in this example, or generic such as the "JMSPriority" property.
Key properties:

**Maximum server sessions**
- How many MDB instances to run in parallel.

**Server session pool timeout**
- How long an unused Server Session is left in the pool before closing. This is used to reduce system resources in low MDB activity periods, or to circumvent problems with TCP/IP and idle sockets.

**Number of sequential delivery**
- Used to stop the Activation Specification should a series of MDB instances not complete successfully.

*Note that this behaves in a different way to Listener Ports.*
The message reported in the application server log file when the number of sequential failed MDB deliveries is reached is:

CWWMQ0007W: The message endpoint <MDB name> has been paused by the system. Message delivery failed to the endpoint more than <X> times. The last attempted delivery failed with the following error:
<error details>

Note that Listener Ports stop using a different algorithm, based on the backout count of the messages being consumed on the MDB source queue, rather than the number of sequential MDB delivery failures.
Message Driven Beans Code Snippet

Method invoked when a message is available

```java
public void onMessage(Message message) {
    try {
        if (message instanceof TextMessage) {
            TextMessage textMsg = (TextMessage)message;
            System.out.println("Message text is "+
                                textMsg.getText());
        }
    } catch (JMSException ex) {
        System.out.println("JMSException occurred : "+ ex);
    }
}
```
The inner workings of the WMQ Activation Specification

Having an overview of how WebSphere MQ Activation Specifications function may help you to understand how to tune your system.
Activation Specifications – Thread Pooling

In order to process a message within an MDB, two resources are needed within the WAS environment:

(1) An **available Server Session**, configured on the Activation Specification.
   • Default = '10'

(2) An **available thread**, configured on the WMQ Resource Adapter for the JVM.
   • Default = '25'

With the default settings, your system could run out of threads for MDB instances with three Activation Specifications, resulting in slower processing and the potential for 'WorkRejectedException' exceptions to be thrown if the time taken to wait for a thread exceeds the 'Start timeout' value configured on the Activation Specification.
What happens if the connection to the queue manager is broken, for example by a network interruption?

The Activation Specification will by default going into recovery, which is configured on the WebSphere MQ Resource Adapter.

Select the 'Show built-in resources' check-box and press 'Apply' to be able to see the WebSphere MQ Resource Adapter.
Activation Specifications – Recovery

The default behaviour is to try to reconnect to the Queue Manager 5 times every 300000ms (5 minutes).

Following the initial connection failure, an immediate reconnection attempt is made, then at the configured intervals.

**Note:**
- If the Activation Specification stops, this is only reported in the application server's SystemOut.log log file, as a message of the following form:

```
```
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Message Properties and Selectors

JMS message selectors allow the filtering of messages which are being consumed by an application.

As of WebSphere MQ v7, the queue manager understands JMS message properties, and the selection work is performed by the queue manager.

Sample JMS snippet code to set user properties:

```java
jmsMessage.setStringProperty("fruit", "apple");
jmsMessage.setIntProperty("weight", 503);
```

This will produce a WMQ message with the RFH2 structure:

```xml
<usr>
  <fruit>apple</fruit>
  <weight>503</weight>
</usr>
```

**Note:** Understand that a Queue Manager is not a database. Using selectors against deep queues can have performance implications.
Asynchronous Message Consumption and Distribution of Messages

JMS has had the concept of the asynchronous message consumer since inception:
- MessageListener / onMessage

Event driven processing is 'natural' within the Java environment.

WebSphere MQ v7 introduced the ability for a Queue Manager to drive a consumer when a message is available.

Message 'polling threads' are no longer necessary. Asynchronous consumers do not use MQGET.

The Queue Manager determines the distribution of messages to the consumers.
Browse-with-Mark

Back in the 'old' days of WebSphere MQ v6 on a distributed platform, activation specifications/Listener Ports in application servers within a WAS cluster would 'fight' over the same message on a queue, due to the two-stage MDB driving method:

1. Browse for a message.
2. Get that message, identified by its CorrelationID and MessageID.

This caused message contention which could significantly slow the MDBs down, and could put a significant load on the queue manager.

This problem was solved in WebSphere MQ v7 on distributed platforms with the browse-with-mark function, where a temporary flag is placed on messages when being browsed. The queue manager property “MARKINT” determines the length of time of the flag. Be aware of the message:

CWSJY0003W: WebSphere classes for JMS attempted to get a message for delivery to an message listener, that had previously been marked using browse-with-mark, but the message was not there.
WebSphere MQ v7.0 introduced the concept of Conversation Sharing. This is where multiple objects communicate with the Queue Manager using a multiplexed TCP/IP socket.

The Queue Manager CHANNEL property 'SHARECNV' determines the number of shared conversations over a single TCP/IP socket, which defaults to the value '10'.

Mapping this to the WebSphere MQ classes for JMS: Every JMS Connection and JMS Session object requires one communication stream – which we term an 'hconn'.

The higher the number of shared conversations, the increased delay there is in a busy system as only one object can communicate at any point in time. However, also the higher the number of allowable shared conversations, the less the need to create an expensive new TCP/IP socket.

Experiment on your systems to find an optimal value for your work load.
Sending Messages from WAS to non-JMS systems, part 1

The default behaviour of the WMQ-JMS classes when sending messages are to store JMS properties within the MQMD and RFH2 headers of the WMQ Message.

If the receiving application is a non-JMS application, it may not be expecting the RFH2. The Destination property 'TARGCLIENT' controls if the RFH2 is created in the sent message.

<table>
<thead>
<tr>
<th>JMS provider specific property name</th>
<th>Field and header used for transmission</th>
<th>Set by</th>
</tr>
</thead>
<tbody>
<tr>
<td>JMSMessageID</td>
<td>MsgID in MQMD</td>
<td>Send Method</td>
</tr>
<tr>
<td>JMSReplyTo</td>
<td>ReplyToQ/ReplyToQMGR in RFH2</td>
<td>Message Object</td>
</tr>
<tr>
<td>JMSRedelivered</td>
<td>Not Applicable</td>
<td>Receive-only</td>
</tr>
</tbody>
</table>
Sending Messages from WAS to non-JMS systems, part 2

When sending messages which are to be consumed by non-JMS applications, you may want to control the format and header data of the WebSphere MQ message.

To achieve for some properties (those starting with the name “JMS_IBM_”) requires additional configuration of the Destination object to allow reading and writing of the MQMD.

MQMD property values are accessed via Java properties on the JMS Message, the names of which are detailed in the WebSphere MQ Information Center under the heading “Mapping JMS fields onto WebSphere MQ fields (outgoing messages)”. Some properties cannot be set by the application when sending the message. Instead these properties are updated in the JMS message by the sending operation itself.

**Use with caution!**

<table>
<thead>
<tr>
<th>JMS provider specific property name</th>
<th>Field and header used for transmission</th>
<th>Set by</th>
</tr>
</thead>
<tbody>
<tr>
<td>JMS_IBM_MsgType</td>
<td>MsgType in MQMD</td>
<td>Message Object</td>
</tr>
<tr>
<td>JMS_IBM_PutTime</td>
<td>PutTime in MQMD</td>
<td>Send Method</td>
</tr>
</tbody>
</table>

Resources → JMS → Queues → [Select Queue] → Advanced properties (From WAS v8)
Read Ahead

In general messages are sent to a JMS application when the application requests it – one at a time.

However an asynchronous JMS consumer can be configured to receive more than one message, using the feature of 'Read Ahead'.

In order for Read Ahead to operate, the following conditions must be met:
- Using non-persistent messages
- OR not destructively consuming messages – for example browsing for messages with an Activation Specification.

Note that if the application terminates unexpectedly, all unconsumed non-persistent messages are discarded.
In JEE, JMS application-specified user and passwords are not necessarily used. Instead, “Container-managed” authentication is deployed.

Activation Specifications / Connection Factories can be associated with authentication data.

JAAS – J2C Authentication Data defines username and password details.

The application needs to use JEE resource-references to access the connection factory.

The `authenticationType` parameter needs to be set to `container` for container-managed authentication.

As for other WMQ clients, security exits are required to validate passwords, WMQ only checks user id.

User IDs became more important with the introduction WMQ 7.1 channel authentication.

Read the following Technote for details:
WMQ’s implementation of Active-Passive failover is the Multi-Instance Queue Manager, which utilises queue manager data stored in network storage system. It requires:

- **OS = Linux, UNIX or Windows**
- **WMQ 7.0.1 or later Queue Manager**
- **WMQ-RA 7.0.1.3 or later (included within WAS 7.0.0.13)**

WAS Connection Factories/Activation Specifications must be configured to locate the queue manager at multiple network addresses. This is achieved using:

- Client Connection Definition Table (CCDT) or
- Connection Name Lists (a comma separate list of hostnames and port numbers, of the form: “hostname1(port1), hostname2(port2)”).

Automatic Client Reconnect is **NOT SUPPORTED** from within the EJB/Web container.
Design the capacity of the WAS MDBs to be sufficient such that one MDB can manage the entire workload.

Then any one system can be removed from this design, and messages will continue to be consumed by the MDB with no loss of service – other than the set of messages which become unavailable if one of the Queue Managers goes down.
Connection and Session pooling is provided by default by WAS for all Connections and Sessions created from a ConnectionFactory looked up from the WAS JNDI.

Length of time to wait for a Connection when the pool is full

Maximum number of Connections which can be created from this ConnectionFactory

Length of time an idle Connection remains in the pool

Length of time a Connection can exist for before being discarded when not in use. **DO NOT USE** this property with WebSphere MQ Connection Factories unless you understand the consequences.
Collecting Diagnostic Data - Enabling Trace

Trace for the WMQ-RA is integrated with the WAS trace system. In general, trace will be requested by IBM Support teams when investigating reported problems. Note the two tabs – “Configuration” and “Runtime”.

A suitable trace string for the WMQ-RA component is:

```
*=info:JMSApi=all:JMSServer=all:Messaging=all:JMS_WASTraceAdapter=all:com.ibm.mq.*=all:jmsApi=all
```

The default trace size of 2 log files (1 historical) and 20Mb maximum log size are normally too small to capture WMQ-RA issues.

A preferred starting size is:

- 200 MB Maximum File Size
- 10 Maximum Number of Historical Files
Investigating your own applications

The trace string used on the previous page results in the internals of the WMQ-RA being captured. This output is not intended for the end user to consume.

Is there another trace string which produces output which might be of more use to the end user?

Yes! See the information in the page on the URI:

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Application Server Hang on Startup

If you have multiple MDBs configured within the same WAS server, and there are messages on the queues when the Activation Specification starts, WMQ-RA threads hang in a logical deadlock, and messages are not consumed.

IZ68236 describes this in detail – all WAS servers running with a WMQ-RA v7.0 are affected by this.

The fix is a configuration change – 'connectionConcurrency' must be set to the value '1' in the WMQ-RA custom properties.

**THIS MUST BE CONFIGURED AT THE CELL SCOPE.**

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<tr>
<th>Name</th>
<th>Value</th>
<th>Description</th>
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</table>

Complete your session evaluations online at www.SHARE.org/Anaheim-Eval
Uneven Distribution of Messages

The original design of the WebSphere MQ v7.0 Queue Manager when working with multiple message consumers was to saturate the first registered consumer before sending messages to the next message consumer.

In the case of an Activation Specification with 10 Server Sessions defined, this means that the first 10 available messages would go to the one WAS server before other WAS servers received messages.

IZ97460 – included in WebSphere MQ 7.0.1.6 – changed this behaviour to a round-robin distribution.
Poor performance of MDBs

There are a number of reasons why your MDBs may slow down, and these can be difficult to diagnose.

Some general tips:

(1) Verify that 'migration mode' is not in use. This is a compatibility layer within the WMQ-RA v7 which allows communication with WMQ v6 Queue Managers. It supports none of the v7 features which enhance MDB performance (browse-with-mark to distributed queue managers).

You cannot directly if it is activated, however you can check for the following activating conditions:

(a) A Connection Factory configured with “Provider Version” set to “6”.
(b) Connecting to a v6 queue manager
(c) Connection to a v7 queue manager with the CHANNEL property 'SHARECNV=0'

(2) Check the depth of the queue which the MDBs are consuming messages from. If it is deep (for example 10,000+ messages), check to see if message selectors are being used, or if the average message size is greater than 4Kb.
My WAS Connection/Session are not behaving as they are supposed to!

Programmatically creating your ConnectionFactory in your application code means that you will bypass the WAS wrappers – meaning that your transactions will not been seen by the WAS transaction manager, and you will have no pooling of JMS Connections and JMS Sessions!

The right way:

```java
Context jndiContext = new InitialContext();
ConnectionFactory myConnectionFactory =
  (ConnectionFactory)jndiContext.lookup("jms/myConnectionFactory");
Connection conn = myConnectionFactory.createConnection();
```

The wrong way:

```java
MQConnectionFactory myConnectionFactory = New MQConnectionFactory;
myConnectionFactory.setQueueManager("myQMGR");
myConnectionFactory.setHostName("localhost");
myConnectionFactory.setChannel("MY.CHANNEL.SVRCONN");
myConnectionFactory.setPort(1414);
myConnectionFactory.setTransportType(WMQConstants.WMQ_CM_CLIENT);
Connection conn = myConnectionFactory.createConnection();
```
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Further Information

WAS product information:  http://www-306.ibm.com/software/webservers/appserv/was/

WAS Information Centers:

6.0  http://publib.boulder.ibm.com/infocenter/wasinfo/v6r0/index.jsp
7.0  http://publib.boulder.ibm.com/infocenter/wasinfo/v7r0/index.jsp
8.0  http://publib.boulder.ibm.com/infocenter/wasinfo/v8r0/index.jsp
8.5  http://publib.boulder.ibm.com/infocenter/wasinfo/v8r5/index.jsp

Product Connectivity Information Center
http://publib.boulder.ibm.com/infocenter/prodconn/v1r0m0/index.jsp

Using WebSphere MQ Java Interfaces in J2EE/JEE Environments

(Searching on “Service Integration Bus” returns a number of interesting articles)

WebSphere Application Server V7: Messaging Administration Guide SG24-7770-00
WebSphere Application Server V7: Concepts, Planning and Design, SG24-7708-00
WebSphere Application Server V7: Technical Overview, REDP-4482-00
WebSphere Application Server V6.1: JMS Problem Determination, REDP-4330-00
WebSphere Application Server V6.1: System Management & Configuration, SG24-7304-00
WebSphere Application Server V6: Scalability and Performance Handbook, SG24-6392-00
WebSphere Application Server V6.1 Security Handbook, SG24-6316-01
WebSphere Application Server V6.1: Technical Overview, REDP-4191-00
WebSphere Application Server V6.1: Planning and Design, SG24-7305-00
WebSphere Application Server V6.1: Installation Problem Determination, REDP-4305-00
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<td>Using IBM WebSphere Application Server and</td>
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<td>Application Integration in the new world</td>
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