Enterprise Messaging With ActiveMQ and Spring JMS

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Agenda

- Installing ActiveMQ
- Configuring ActiveMQ
- Using Spring JMS with ActiveMQ
- Some ActiveMQ Features

What is ActiveMQ?

- Open source
- Message-oriented middleware
- Apache project
  - http://activemq.apache.org/
- Apache licensed
- JMS 1.1 compliant
- Goal:
  - To achieve standards-based, message-oriented application integration across many languages and platforms

Installing ActiveMQ

- Download it
- Unzip it
- Run it

- It’s really that simple!

Configuring ActiveMQ

(conf/activemq.xml)

Configuring ActiveMQ

- XML configuration

```
<amq:broker id="broker" persistent="false" useJmx="true">
   <amq:transportConnectors>
     <amq:transportConnector name="openwire" uri="tcp://localhost:0" />
   </amq:transportConnectors>
 </amq:broker>
```

Configuring ActiveMQ

- Pure Java configuration
  - Used to embed ActiveMQ in a Java app

```
BrokerService broker = new BrokerService();
broker.setPersistence(false);
TransportConnector connector = broker.addConnector("tcp://localhost:61616");
broker.start();

...

connector.stop();
broker.stop();
```

ActiveMQ Uses URIs For Transport Configuration

<protocol>://<host>:<port>?<transport-options>

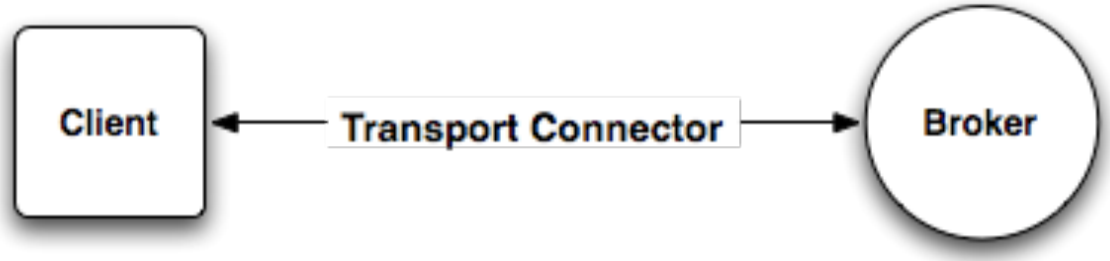
```
vm://embedded?broker.persistent=false

tcp://localhost:61616?jms.useAsyncSend=true

stomp://localhost:61613

failover:(tcp://host1:61616,tcp://host2:61616)?
initialReconnectDelay=100
```

Wire Formats

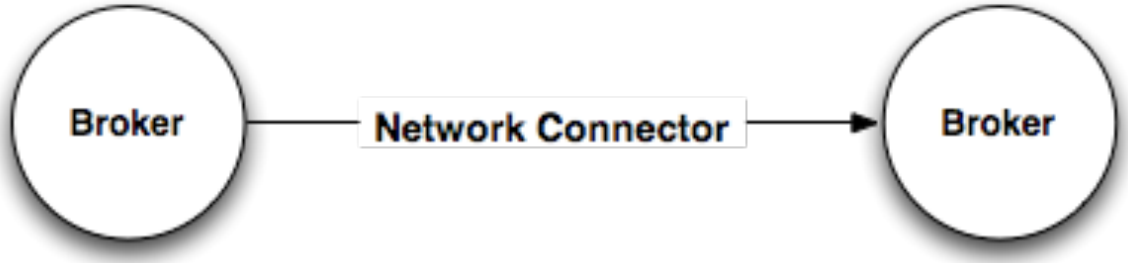
- OpenWire
  - The default in ActiveMQ; a binary protocol
  - Clients for C++, Java and .NET
- STOMP
  - Simple Text Oriented Messaging Protocol; a text based protocol
  - Clients for C, Javascript, Perl, PHP, Python, Ruby and more
- XMPP
  - The Jabber XML protocol
- REST
  - HTTP POST and GET

Two Types of Transports

- Client-to-broker communications



- Broker-to-broker communications



Transport Connectors

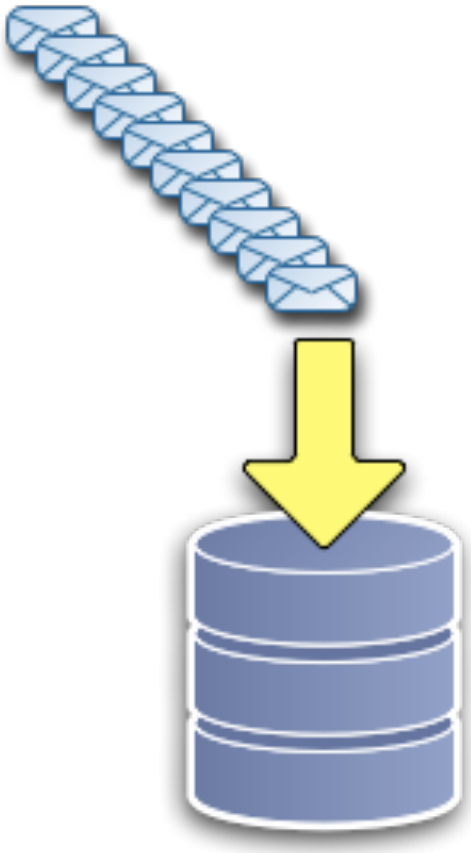
- Client-to-broker connections
  - Similar to JDBC connections to a database
- Protocols are supported:
  - TCP
  - UDP
  - NIO
  - SSL
  - HTTP/S
  - VM
  - XMPP

Network Connectors

- Broker-to-broker connections
  - A cluster of ActiveMQ instances
  - Known as a network of brokers
- Protocols supported:
  - Static
  - Failover
  - Multicast
  - Zeroconf
  - Peer
  - Fanout
  - Discovery

Message Persistence

- AMQ Store
- JDBC
- Journaled JDBC



AMQ Message Store

- Transactional message storage solution
- Fast and reliable
- Composed of two parts:
  - Data Store - holds messages in a transactional journal
  - Reference store - stores message locations for fast retrieval
- The default message store in ActiveMQ 5

Non-Journaled JDBC

- Transactional message storage solution
- Reliable but not fast
  - JDBC connection overhead is prohibitively slow

Journaled JDBC

- Transactional message storage solution
- Reliable and faster than non-journaled
- Two-piece store
  - Journal - A high-performance, transactional journal
  - Database - A relational database of your choice
- Default database in ActiveMQ 4.x was Apache Derby

Master/Slave Configurations

- Pure master/slave
- Shared filesystem master/slave
- JDBC master/slave

Pure Master/Slave

- Shared nothing, fully replicated topology
  - Does not depend on shared filesystem or database
- A Slave broker consumes all commands from the master broker (messages, acks, tx states)
- Slave does not start any networking or transport connectors
- Master broker will only respond to client after a message exchange has been successfully replicated to the slave broker

Pure Master/Slave

- If the master fails, the slave optionally has two modes of operation:
  - Start up all it's network and transport connectors
    - All clients connected to failed Master resume on Slave
  - Close down completely
    - Slave is simply used to duplicate state from Master

Shared Filesystem Master/Slave

- Utilizes a directory on a shared filesystem
- No restriction on number of brokers
- Simple configuration (point to the data dir)
- One master selected at random

JDBC Master/Slave

- Recommended when using a shared database
- No restriction on the number of brokers
- Simple configuration
- Clustered database negates single point of failure
- One master selected at random

Client Connectivity With Master/Slave

- Clients should use the failover transport for **automatic reconnect** to the broker:

```
failover:(tcp://broker1:61616,\
tcp://broker2:61616, \
tcp://broker3:61616)?\
initialReconnectDelay=100
```

Broker Security

- Authentication
  - I.e., are you allowed to connect to ActiveMQ?
  - File based implementation
  - JAAS based implementation

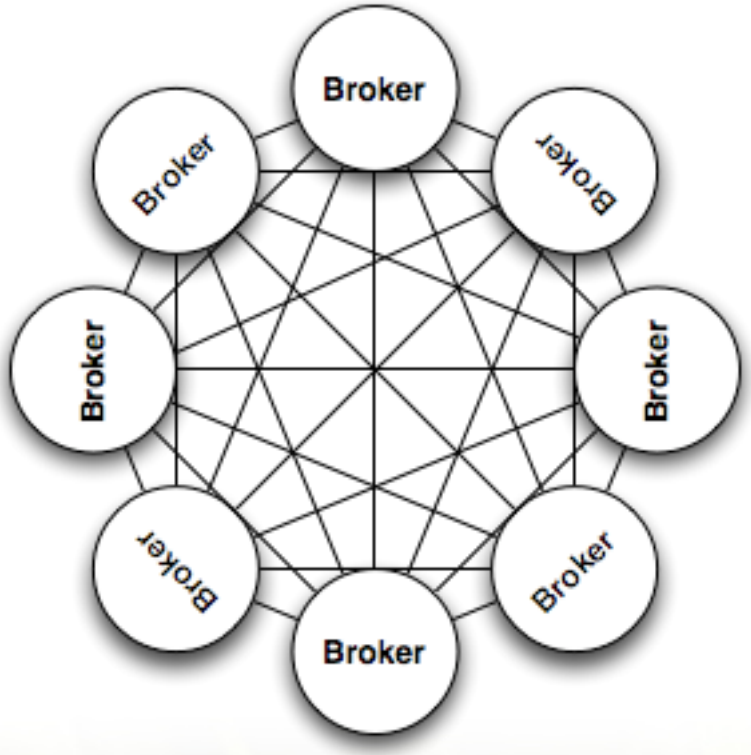
- Authorization
  - I.e., do you have permission to use that ActiveMQ resource?
  - Destination level
  - Message level via custom plugin

Networks of Brokers

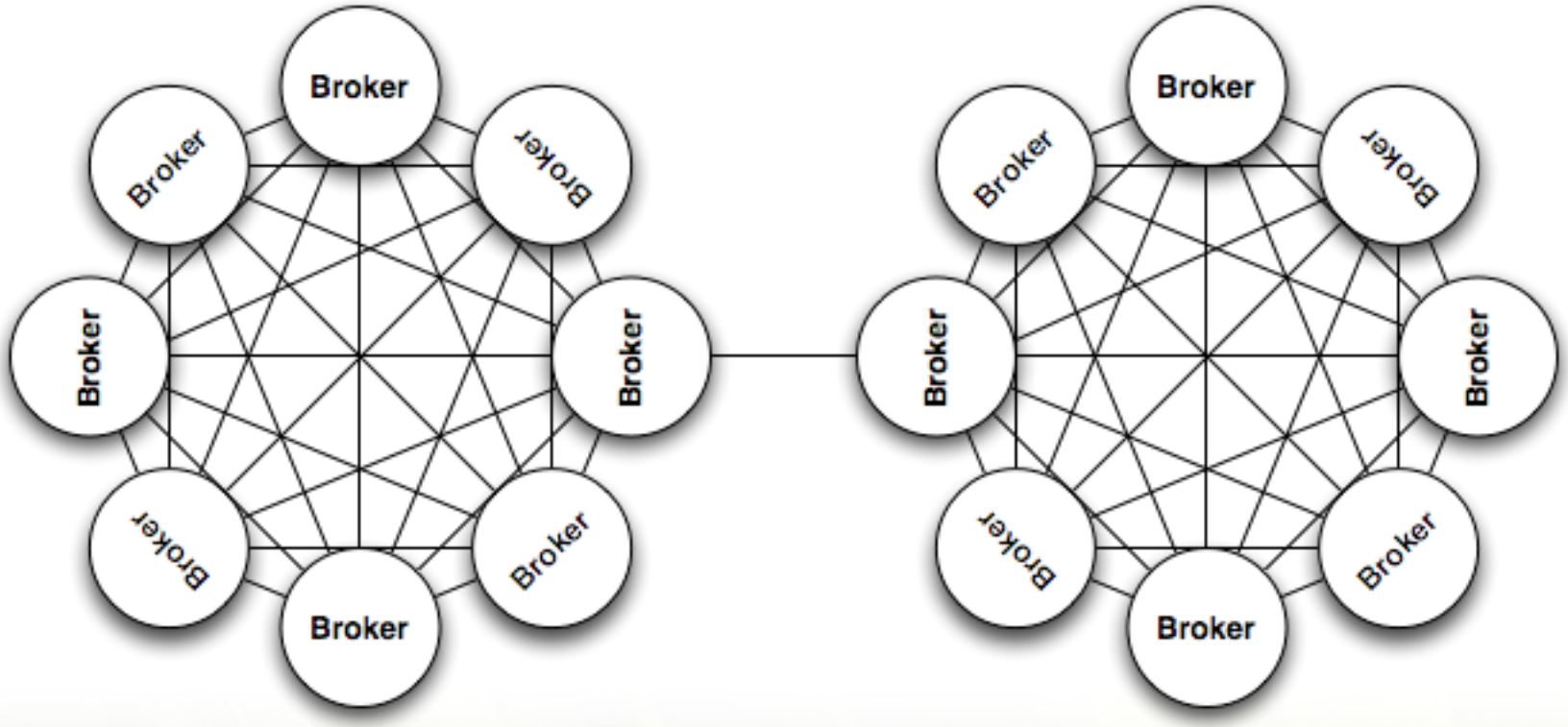
- Many brokers acting together in a cluster
- Provides large scalability
- ActiveMQ store-and-forward allows messages to traverse brokers in the network
  - Demand-based forwarding
  - Some people call this distributed queues
- Many possible configurations or topologies are supported

Topology Example

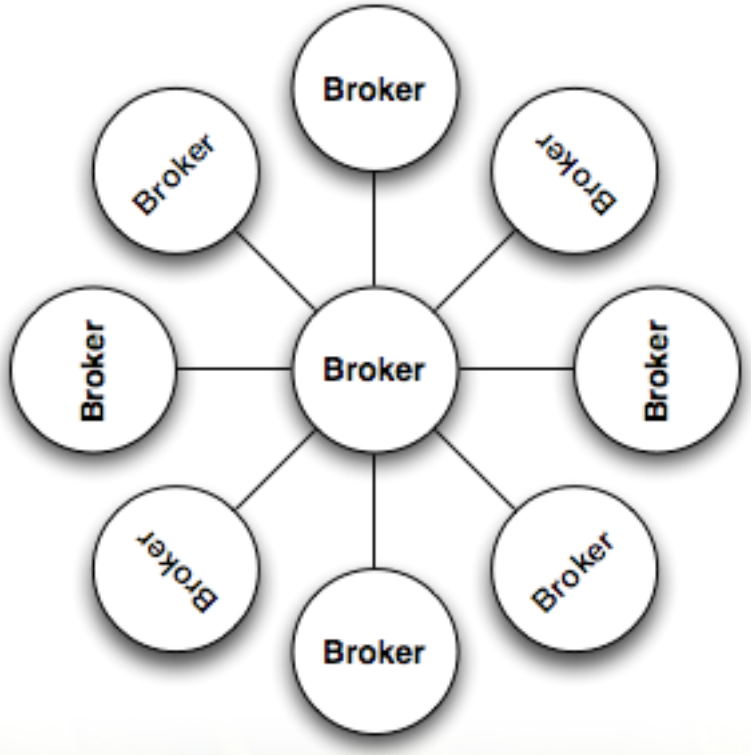
Topology Example



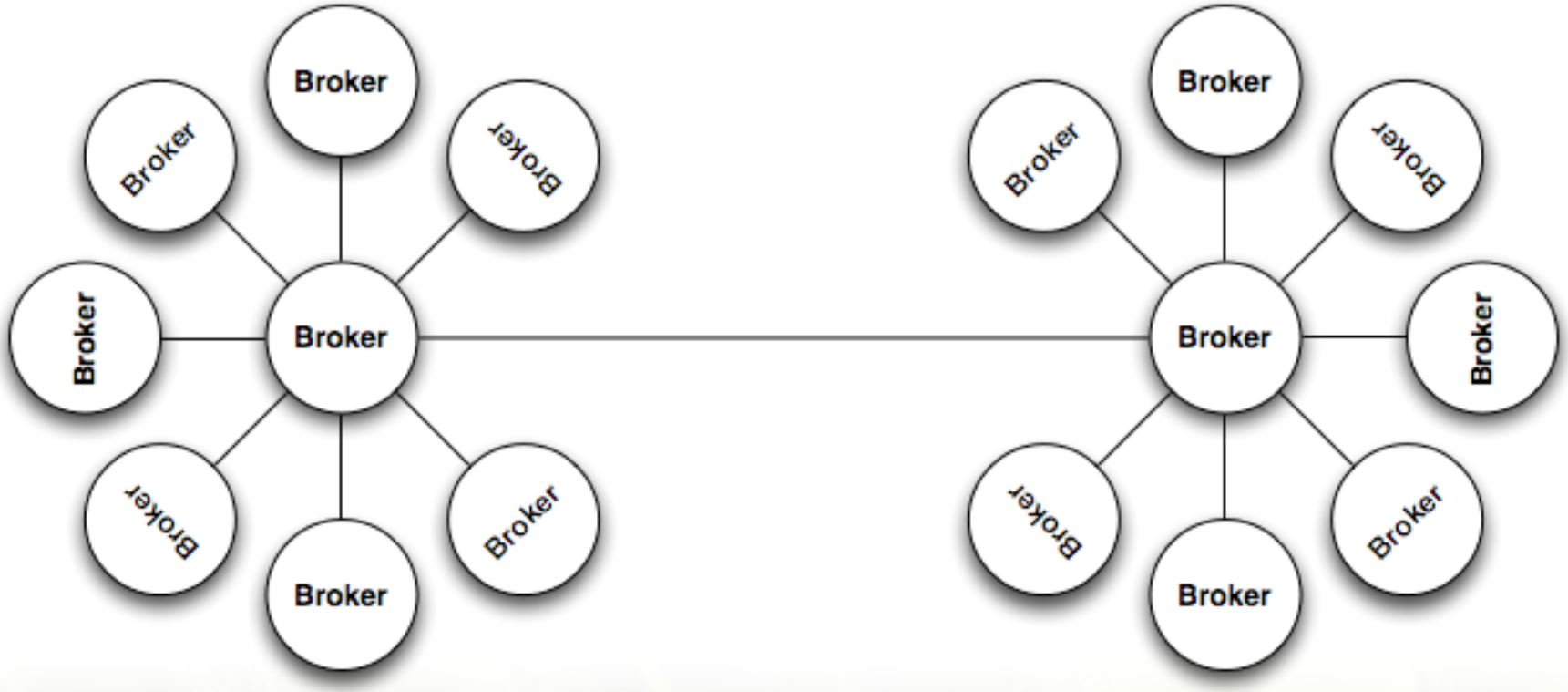
Topology Example



Topology Example



Topology Example



Using ActiveMQ In Your Applications

1 

DIY

2 **EJB**

3 

JMS

DIY/Roll Your Own

- Advantages
  - Do whatever you want - it's a green field!
- Disadvantages
  - Manual creation of MessageProducers and MessageConsumers
  - Manual concurrency management
  - Manual thread management
  - Manual transaction management
  - Manual resource management
    - ConnectionFactory, Connections, Destinations

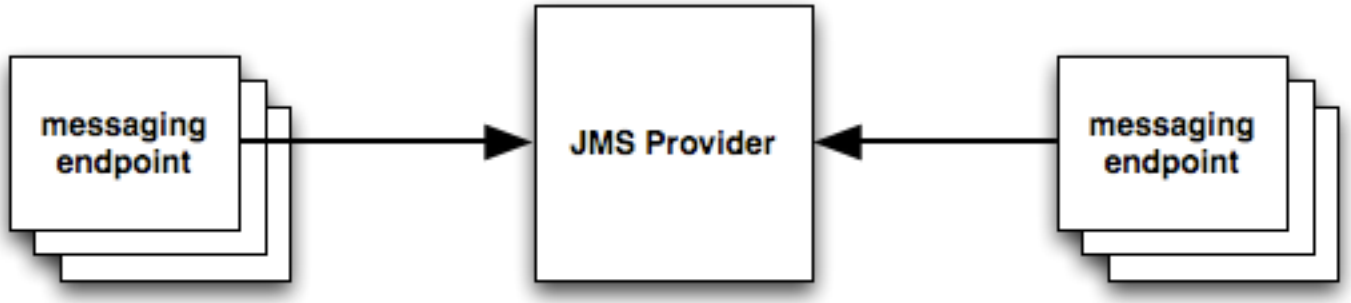
EJB:Message Driven Beans

- Advantages
  - Automatic Transaction management
  - Automatic Concurrency
  - Automatic resource management
    - ConnectionFactory, Connections, Destinations
- Disadvantages
  - Requires EJB container and therefore a JEE server
    - Exception: Apache OpenEJB (http://openejb.apache.org/)
  - Increased overhead

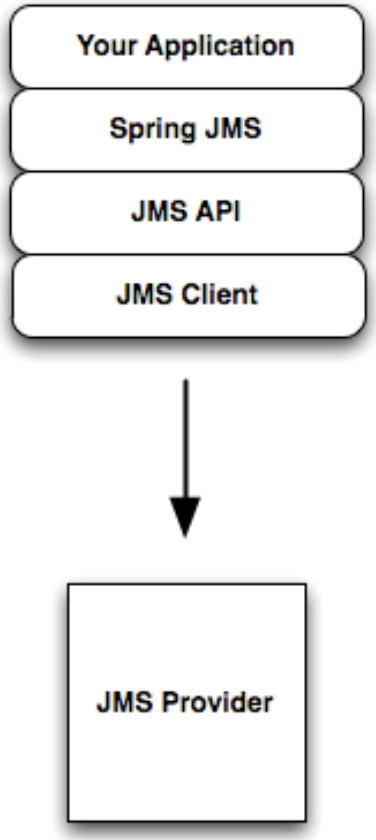
Spring JMS

- Advantages
  - No EJB container required (no JEE container)
  - Simplified resource management
    - ConnectionFactory, Connections, Destinations
  - Simplified concurrency management
  - Simplified transaction management
- Disadvantages
  - Are there any? ;-)

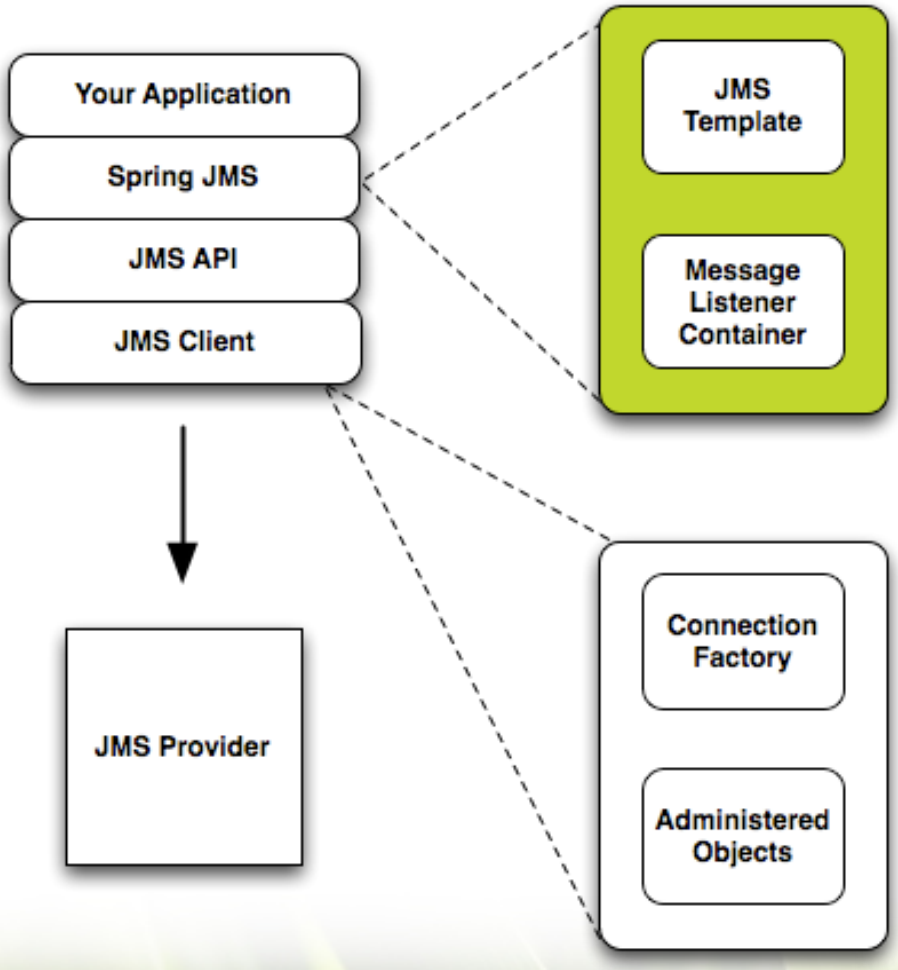
Typical JMS Applications



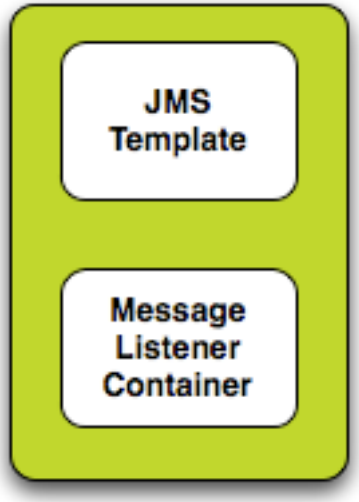
JMS With Spring



JMS With Spring



Spring JMS



- JMS Template
  - Send and receive messages synchronously
- Message Listener Container
  - Receive messages asynchronously
  - Message-Driven POJOs (MDPs)

JmsTemplate

Synchronous

- browse()
  - Browse messages in a queue
- convertAndSend()
  - Send messages synchronously
  - Convert a Java object to a JMS message
- execute()
  - Provides access to callbacks for more complex scenarios
- receive() and receiveAndConvert()
  - Receive messages synchronously
- receiveSelected() and receiveSelectedAndConvert()
  - Receive filtered messages synchronously
- send()
  - Send a message synchronously using a MessageCreator

The Spring JmsTemplate

Synchronous

- Send using convertAndSend()
  - Converts an object to a JMS message with a configured MessageConverter

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

jmsTemplate.convertAndSend("Hello World!");
```

The Spring JmsTemplate

Synchronous

- Using send() with a MessageCreator
  - Provides access to Session for more complex message creation

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

jmsTemplate.send(destination, new MessageCreator() {
  public Message createMessage(Session session)
    throws JMSException {
      return session.createTextMessage("Hello World!");
    }
  });
```

The Spring JmsTemplate

Synchronous

- Using execute() and the SessionCallback
  - Provides access to the Session for flexibility

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

jmsTemplate.execute(new SessionCallback() {
  public Object doInJms(Session session) throws JMSException {
      Queue queue = session.createQueue("MY.TEST.QUEUE");
      MessageProducer producer = session.createProducer(queue);
      TextMessage message = session.createTextMessage("Hello World!");
      producer.send(message);
  }
});
```

The Spring JmsTemplate

Synchronous

- Using execute() with the ProducerCallback
  - Provides access to the Session and the MessageProducer for more complex scenarios

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

jmsTemplate.execute(new ProducerCallback() {
   public Object doInJms(Session session, MessageProducer producer)
    throws JMSException {
      TextMessage message = session.createTextMessage("Hello World!");
      producer.send(destination, message);
   }
   return null;
 }
```

The Spring JmsTemplate

Synchronous

- Using receive()
  - Very straightforward
  - Accepts a destination object or the destination name as a String

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

jmsTemplate.receive(destination);
```

The Spring JmsTemplate

Synchronous

- Using receiveAndConvert()
  - Converts an object to a JMS message with a configured MessageConverter

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

jmsTemplate.receiveAndConvert(destination, new MessageCreator() {
  public Message createMessage(Session session)
    throws JMSException {
      return session.createTextMessage("Hello World!");
    }
  });
```

The Spring JmsTemplate

Synchronous

- Using receiveSelected()
  - Makes use of a JMS selector expression

```
@Autowired
Destination destination;
@Autowired
JmsTemplate jmsTemplate;

String selectorExpression = " Timestamp BETWEEN 1218048453251 AND
1218048484330";

jmsTemplate.receiveSelected(destination, selectorExpression);
```

Message-Driven POJOs

Asynchronous

- Message Listener Container
  - SimpleMessageListenerContainer
    - Very basic
    - Static configuration
    - No external transaction support
  - DefaultMessageListenerContainer
    - Most commonly used container
    - Allows for dynamic scaling of queue consumers
    - Participates in external transactions
  - ServerSessionMessageListenerContainer
    - Requires provider support of the ServerSessionPool SPI
    - Most powerful (dynamic session management)

Message-Driven POJOs

Asynchronous

- Three types of listeners:
  - javax.jms.MessageListener interface
    - Standard JEE interface
    - Threading is up to you
  - SessionAwareMessageListener interface
    - Spring-specific interface
    - Provides access to the Session object
      - Useful for request-response messaging
    - Client must handle exceptions
  - MessageListenerAdapter interface
    - Spring-specific interface
    - Allows for type-specific message handling
    - No JMS dependencies whatsoever

MessageListener

Asynchronous

- Standard JMS MessageListener
- Uses an onMessage() method

```
public class MyMessageListener implements MessageListener {
    private static Logger LOG = Logger.getLogger(MyMessageListener.class);

    public void onMessage(Message message) throws JMSException {
        try {
            LOG.info("Consumed message: “ + message);
            // Do some processing here
        } catch (JMSException e) {
            LOG.error(e.getMessage(), e);
        }
    }
```

SessionAwareMessageListener

Asynchronous

- Provides access to the session
- Uses an onMessage() method

```
public class MySessionAwareMessageListener implements SessionAwareMessageListener {
    private static Logger LOG = Logger.getLogger(MySessionAwareMessageListener.class);

    public void onMessage(Message message, Session session) throws JMSException {
        try {
            LOG.info("Consumed message: “ + message);
            TextMessage newMessage = session.createTextMessage(“This is a test”);

            MessageProducer producer =  session.createProducer(message.getJMSReplyTo());
            LOG.info("Sending reply message: " + messageCount);
            producer.send(newMessage);
        } catch (JMSException e) {
            LOG.error(e.getMessage(), e);
        }
    }
```

MessageListenerAdapter

Asynchronous

- Handles all message contents
- No reply message is sent (void return)

```
public interface MyMessageListenerAdapter {
    void handleMessage(String text);
    void handleMessage(Map map);
    void handleMessage(byte[] bytes);
    void handleMessage(Serializable obj);
}
```

MessageListenerAdapter

Asynchronous

- Handles all raw JMS message types
- No reply message is sent (void return)

```
public interface MyMessageListenerAdapter {
   void handleMessage(TextMessage message);
   void handleMessage(MapMessage message);
   void handleMessage(BytesMessage message);
   void handleMessage(ObjectMessage message);
}
```

MessageListenerAdapter

Asynchronous

- Handles String content
- No reply message is sent (void return)
- Method name must be explicitly configured

```
public interface MyMessageListenerAdapter {
   void processMessage(String message);
 }

-------------------------------------------------------

<jms:listener-container
   container-type="default"
   connection-factory="consumerConnectionFactory"
   acknowledge="auto">
   <jms:listener destination="SPRING.ONE" ref="myMessageListenerAdapter"
      method="processMessage" />
  </jms:listener-container>
```

MessageListenerAdapter

Asynchronous

- Handles String content
- A TextMessage reply message is sent (String return)

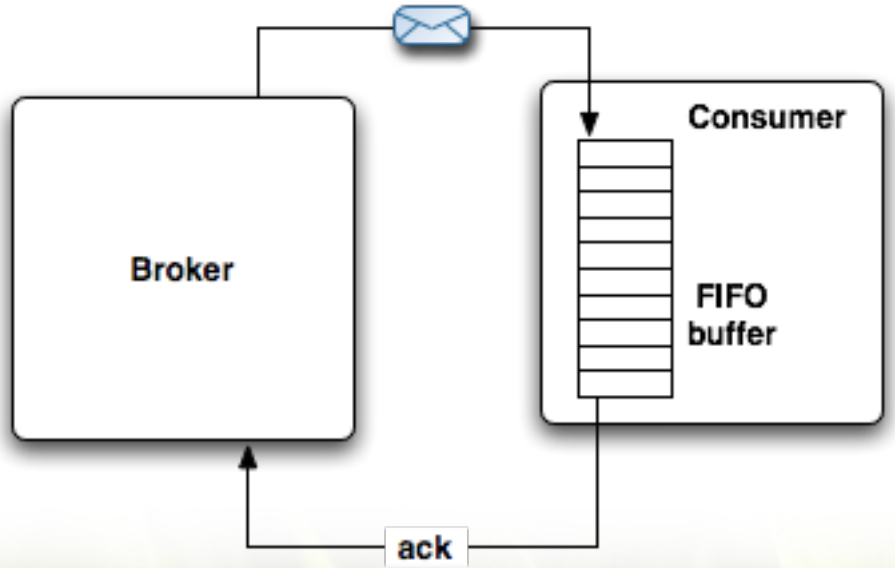
```
public interface MyMessageListenerAdapter {
    String handleMessage(String message);
 }

-------------------------------------------------------

<jms:listener-container
    container-type="default"
    connection-factory="consumerConnectionFactory"
    acknowledge="auto">
    <jms:listener destination="SPRING.ONE" ref="myMessageListenerAdapter"
        method="processMessage" />
  </jms:listener-container>
```

ActiveMQ Consumer Options

- Message prefetch
- Exclusive consumer
- Consumer priority
- Message groups
- Redelivery policies
- Retroactive consumer
- Selectors

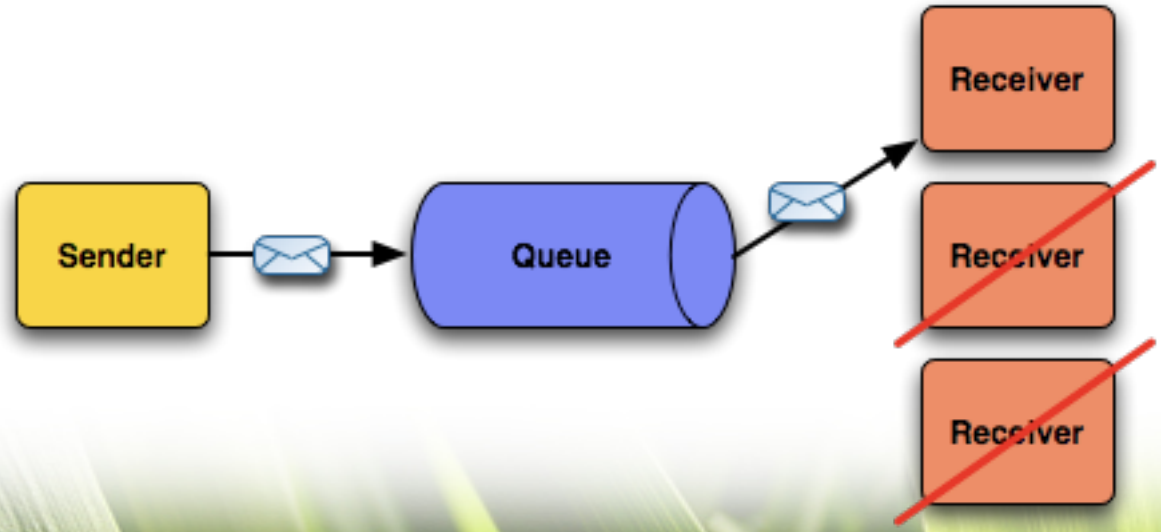
Message Prefetch

- Used for slow consumer situations
  - Prevents flooding the consumer
- FIFO buffer on the consumer side



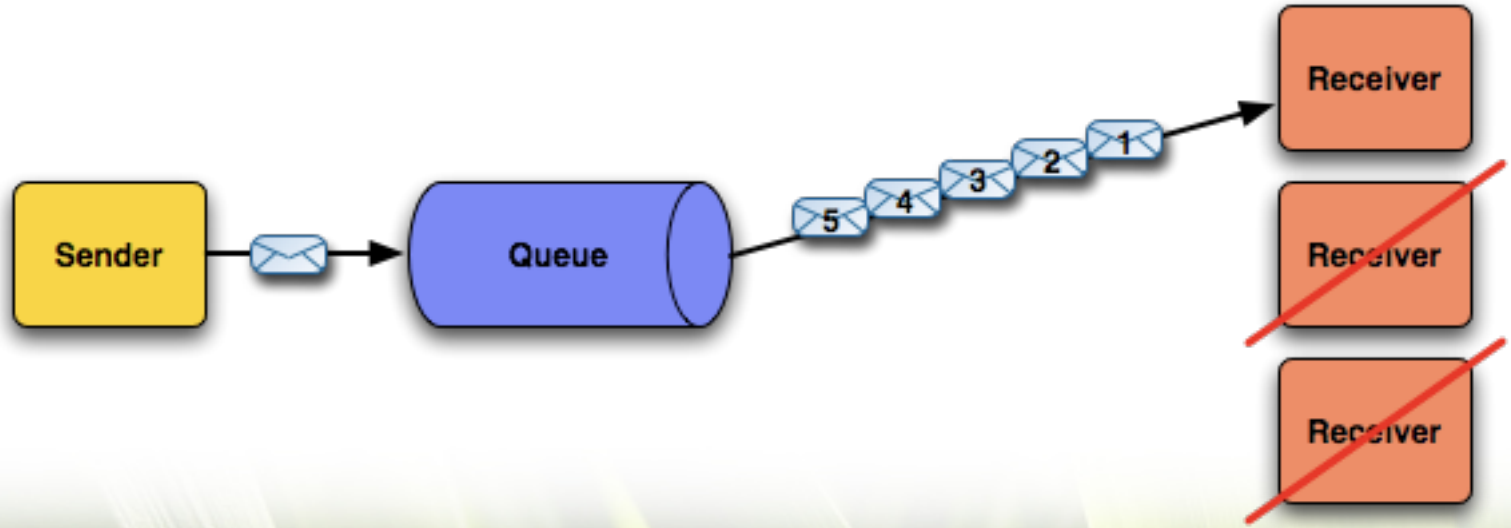
Exclusive Consumer

- Anytime more than one consumer is consuming from a queue, message order is lost
- Allows a single consumer to consume all messages on a queue to maintain message ordering



Consumer Priority

- Gives a consumer preference for message delivery
- Allows for the weighting of consumers to optimize network traversal for message delivery



Message Groups

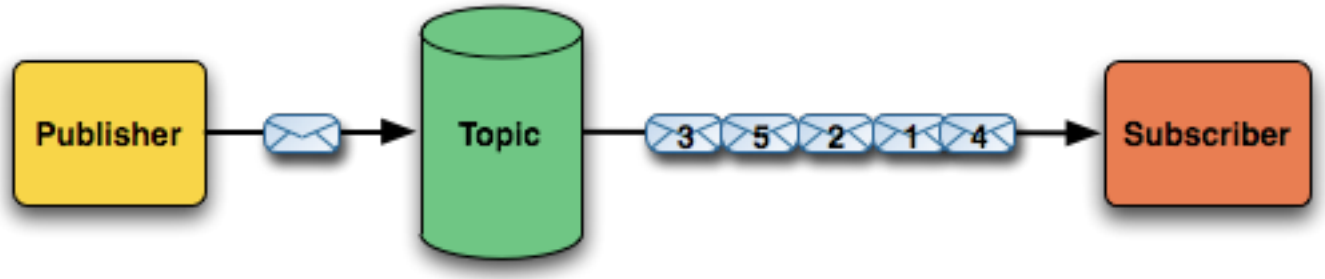
- Uses the JMSXGroupID property to mark messages
- One consumer receives all messages in the group until JMSXGroupID is reset
- Allows one consumer to handle all messages in a group

Redelivery Policy

- Messages are redelivered to a client when:
  - A transacted session is rolled back
  - A transacted session is closed before commit
  - A session is using CLIENT_ACKNOWLEDGE and Session.recover() is explicitly called
- Clients can override the redelivery policy
  - Must be configured on the ActiveMQConnectionFactory or the ActiveMQConnection
    - max redeliveries, initial redelivery delay, exponential backoff, backoff multiplier, etc.
- Dead Letter Strategy can be configured using a destination policy in the activemq.xml

Retroactive Consumer

- Message replay at start of a subscription
  - At the start of every subscription, send any old messages that the consumer may have missed
  - Configurable via policies



Message Selectors

- Used to attach a filter to a subscription
- Defined using a subset SQL 92 syntax
- JMS selectors
  - Filters only message properties
    - JMSType = ‘stock’ and trader = ‘bob’ and price < ‘105’
- XPath selectors
  - Filters message bodies that contain XML
    - ‘/message/cheese/text() = 'swiss''

Other Handy Features

- Destination Policies
- Virtual Destinations
- Total Ordering of Messages
- Mirrored Queues

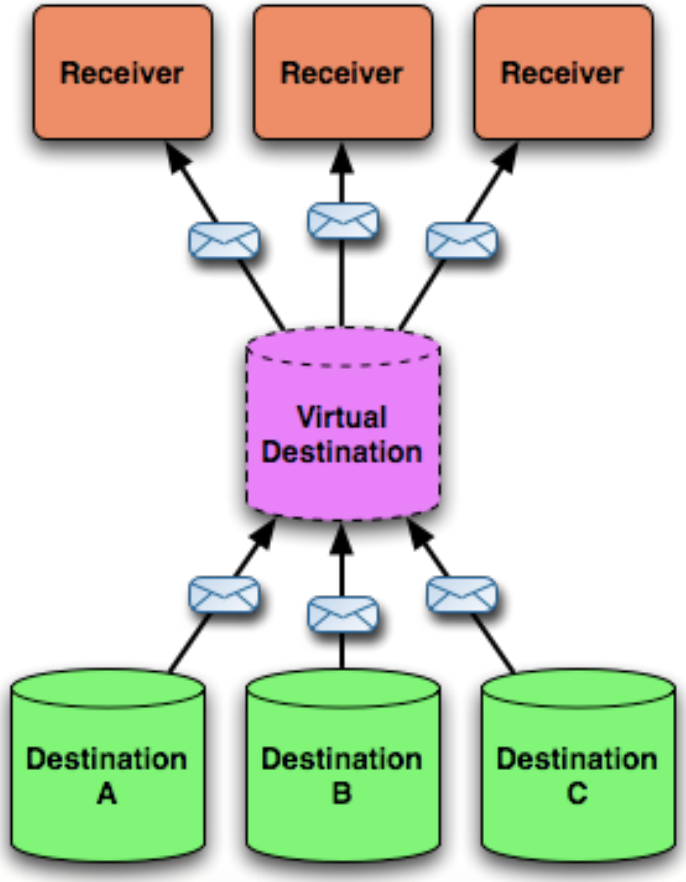
Wildcards and Destination Policies

```
...
<destinationPolicy>
  <policyMap>
    <policyEntries>
      <policyEntry topic="Price.Stock.>"
          memoryLimit="128mb">
    </policyEntries>
  </policyMap>
</destinationPolicy>
...
```

- Price.>
- Price.Stock.>
- Price.Stock.NASDAQ.*
- Price.Stock.*.IBM

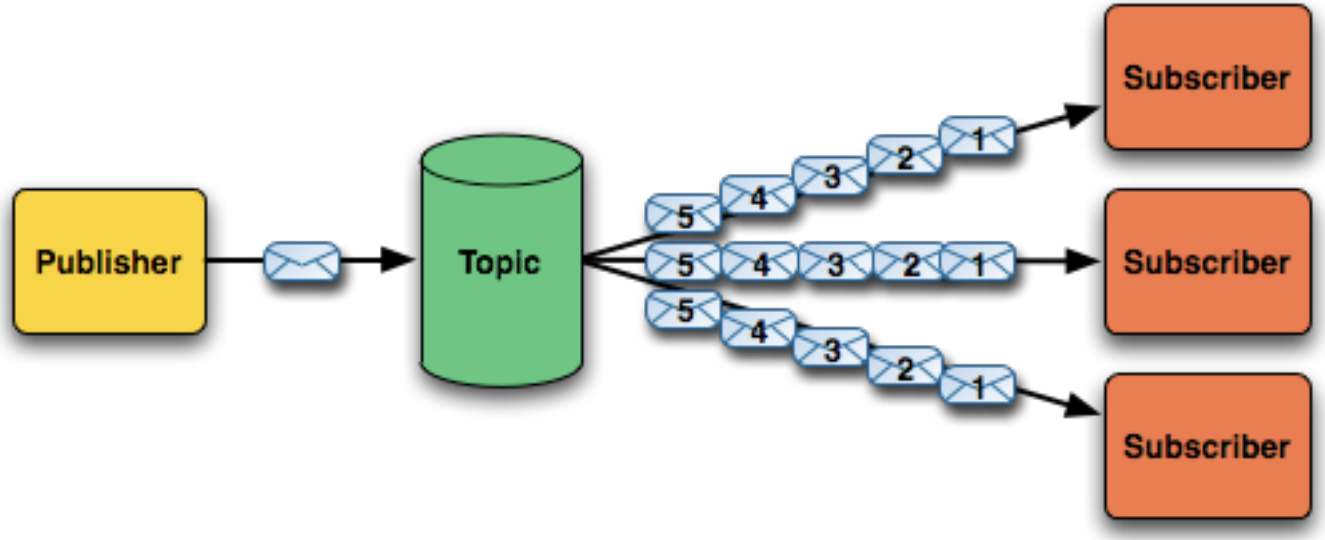
> - Everything recursively
* - Everything at that level

Virtual Destinations

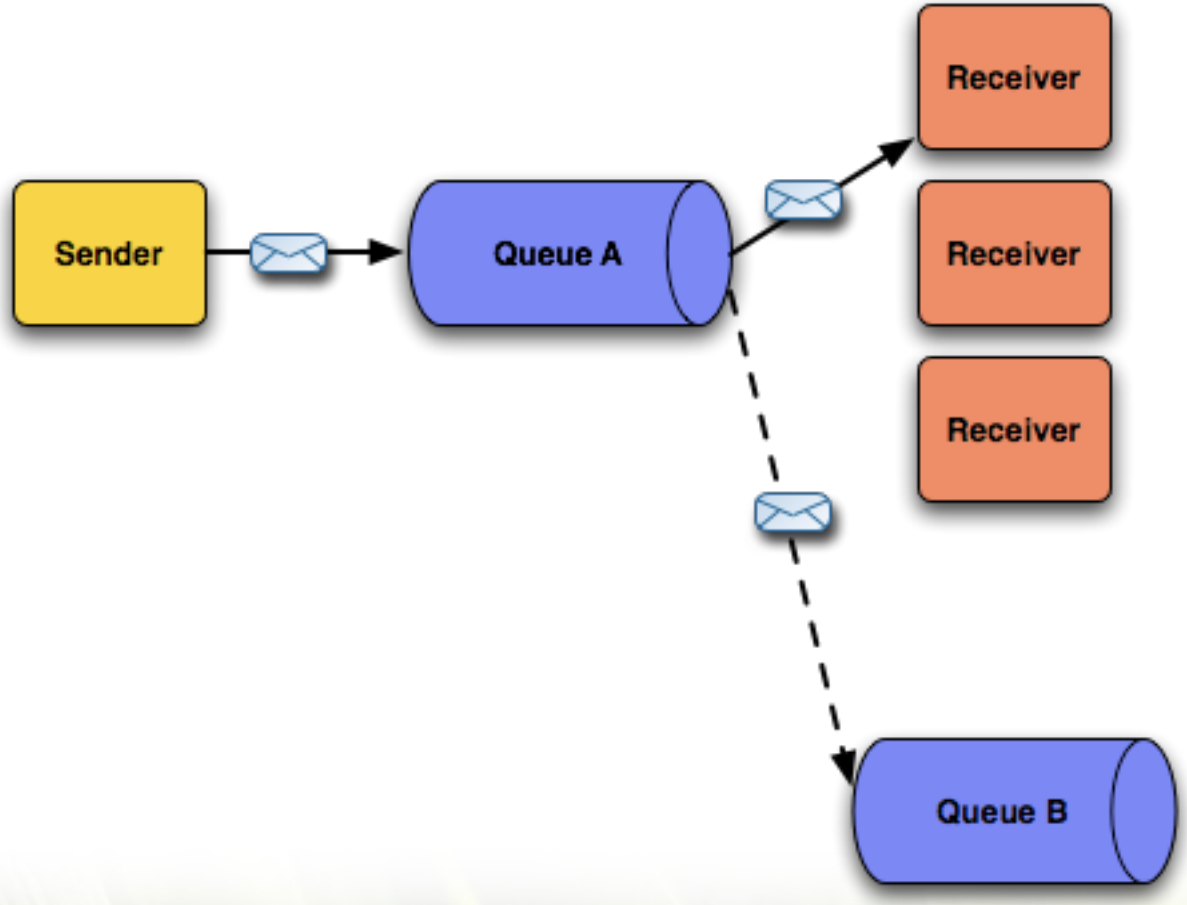


Total Ordering

- A guaranteed order of messages for each consumer

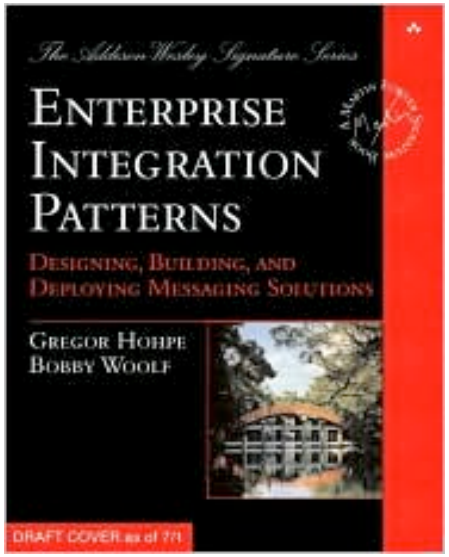


Mirrored Queues



What is Apache Camel?

=>



Camel Components

ActiveMQ	File	JBI	MINA	RMI	TCP
ActiveMQ Journal	FIX	JCR	Mock	RNC	Test
AMQP	Flatpack	JDBC	MSMQ	RNG	Timer
Atom	FTP	Jetty	MSV	SEDA	UDP
Bean	Hibernate	JMS	Multicast	SFTP	Validation
CXF	HTTP	JPA	POJO	SMTP	Velocity
DataSet	iBATIS	JT/400	POP	Spring Integration	VM
Direct	IMAP	List	Quartz	SQL	XMPP
Esper	IRC	Log	Queue	Stream	XQuery
Event	JavaSpace	Mail	Ref	String Template	XSLT

Message Routing Made Easy

- Java API for message routing

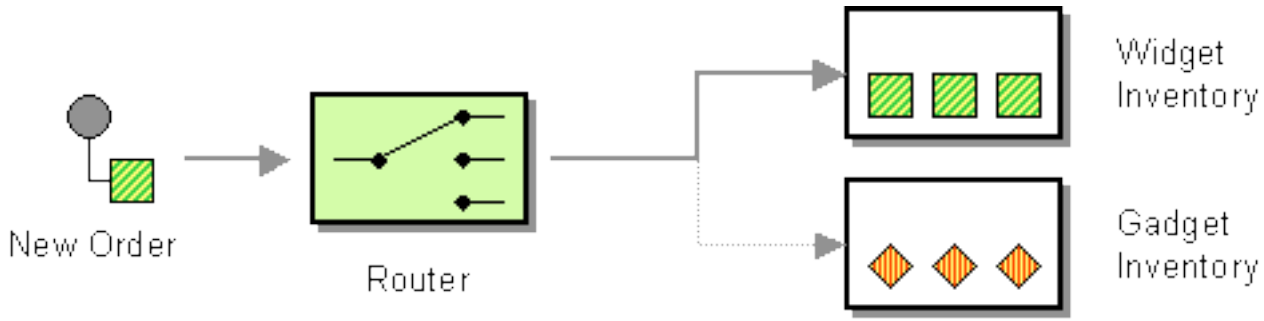
```
package com.mycompany.routes;

    public class MyRoute extends RouteBuilder {
      public void configure() {
        from("activemq:TEST.QUEUE").
          to("file:///opt/inbox/text.txt").
          to("log:MyLog?showProperties=true");
      }
    };
}
```

Message Routing Made Easy

- XML flavor as well

```
<camelContext id="camel"
      xmlns="http://activemq.apache.org/camel/schema/spring">
      <package>com.mycompany</package>
      <route>
            <from uri="activemq:example.A" />
            <to uri="file:///opt/inbox/text.txt" />
            <to uri="log:MyLog?showProperties=true" />
      </route>
</camelContext>
```

Content Based Router - Java DSL




```
RouteBuilder simpleChoiceRoute = new RouteBuilder() {
  public void configure() {
    from("file:/opt/inbox").choice().
     when(header("foo").isEqualTo("bar")).
       to("activemq:QUEUE.A").
     when(header("foo").isEqualTo("cheese")).
       to("jbi:service:http://com/mycompany/MyService").
     otherwise().
       to("file:/opt/outbox-foo");
  }
};
```

Content Based Router - Spring DSL

```
<camelContext id="simpleChoiceRoute">
    <route>
      <from uri="file:/opt/inbox" />
        <choice>
            <when>
                <predicate>
                    <header name="foo" />
                    <isEqualTo value="bar" />
                </predicate>
                <to uri="activemq:QUEUE.A" />
            </when>
            <when>
                <predicate>
                    <header name="foo" />
                    <isEqualTo value="cheese" />
                </predicate>
                <to uri="jbi:service:http://com/mycompany/MyService" />
            </when>
            <otherwise>
                <to uri="file:/opt/outbox-foo" />
            </otherwise>
        </choice>
    </route>
</camelContext>
```

Thank You For Attending!

- Questions and answers

Coming soon:
ActiveMQ in Action ===>