

Middleware and Web Services

Lecture 5: Messaging Systems

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Modified: Thu May 18 2017, 10:31:52
Humla v0.3

Overview

- Messaging Systems
 - *Point-to-Point*
 - *Error Handling*
 - *Publish/Subscribe*
- Store and Forward

Recall: Asynchronous via Intermediary

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- Intermediary
 - *A component that decouples a client-server communication*
 - *It increases reliability and performance*
 - *The server may not be available when a client sends a request*
 - *There can be multiple servers that can handle the request*

Messaging Systems

- Messaging Systems
 - Also *"Messaging Middleware" or "Message-Oriented Middleware" (MOM)*
 - *Two roles: a message consumer and a message producer*
 - *Asynchronous communication*
 - *"anonymity" between producers and consumers*
 - *no matter "who", "where", "when" produced a message*
 - *Ensures reliability and scalability*
- Loose coupling of applications
 - *A producer does not need to know about a consumer*
 - *Messaging systems decouple a producer and a consumer*
- Two types (Messaging Domains)
 - *Point-to-Point (message queue — MQ)*
 - *Publish/Subscribe (event-based)*

Java Message Service

- JMS – Java Message Service
 - *Java API for Message-Oriented Middleware*
 - *Java programs to create, send, receive and read messages*
 - *Standardized in JSR 914* [🔗](#)
- Terminology
 - **JMS Provider** – *implementation of JMS system, part of application server*
 - **JMS Client** – *application that sends or receives JMS messages*
 - **JMS producer/publisher** – *creates and sends messages*
 - **JMS consumer/subscriber** – *receives and processes the messages*
 - **JMS Message** – *an object with data (payload) and properties*
 - **JMS Queue** – *storage that contains sent messages that are to be received; messages are processed only once*
 - **JMS Topic** – *storage that distributes messages to multiple subscribers*

Overview

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Conceptual Architecture

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- *"1 : 1" relationship between a producer and a consumer*
 - ***one message must be processed by one consumer***
- ***no time-dependency** between message producer and consumer*
 - *consumer does not need to exist when producer sends a message*
- *Message exists in the queue until it is used by a consumer*
- *message consumers take as many messages as they are able to serve*

Basic Types of Queues

- Queues in client-server architecture (request-response)
- Input Queue
 - *a client places a message to the queue*
 - *a server reads the message and process it*
- Output Queue
 - *a server places output message (response) to the queue*
 - *a client reads the message*
- Error Queue
 - *a server reads the message from the input queue*
 - *when processing of the message fails, the server places the message to the error queue*
 - *there can be several attempts to process the message before it is placed to the error queue*

JMS Queues

- JMS Provider implemented by Weblogic
- Configuration
 1. Create a **JMS server**, targeted to a managed server
 - In a cluster, every managed server has its own JMS server
 - JMS server has a persistent store where it stores messages in queues (persistent store can be file-based or JDBC-based)
 2. Create a queue, specify a JNDI name for the queue
 - a **queue** targeted to a single JMS server
 - a **distributed queue** targeted to the cluster (all JMS servers)
 3. Create a **connection factory** (optional), specify a JNDI name for the connection factory
 - A JMS client uses the connection factory to create a connection with the JMS server
- Run a JMS client
 - a JMS producer – sends a message to the queue
 - a JMS consumer – receives a message from the queue

JMS Message

- JMS Message Header
 - *Priority*
 - *priority that will be used to consume the message*
 - *normal priority – 1-4, high priority 5-9*
 - *Delivery mode*
 - *persistent – message stored in a storage during send operation*
 - *non-persistent – JMS server only stores the message in memory*
 - *Time to live*
 - *The time the message stays in the queue, the message is removed after it elapses*
 - *The JMS consumer must consume the message before the time elapses*
 - *Message ID*
 - *ID of the message set by the client (in request-response communication)*
 - *Reply To*
 - *A response queue set by the client*
 - *Correlation ID*
 - *ID of the message set by the receiver for response*
- Payload (data)
 - *text, map message (key-values), byte message, object message (serializable java object)*

Conversation in Request-Response

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- Steps
 1. *Client sends a message to the request queue with some message ID1*
 2. *Server receives it, process it and sends a response to the response queue*
 - *The response message has its own message ID3 and a correlation ID that has a value of message ID1*
 3. *Client receives the response message and correlates with the request message*

Example Queues Configuration in Weblogic

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Weblogic Configuration

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JMS Producer Example (1)

```
1  public class JMSProducer {
2
3      // connection factory, connection, session, sender, message
4      private QueueConnectionFactory qconFactory;
5      private QueueConnection qcon;
6      private QueueSession qsession;
7      private QueueSender qsender;
8      private Queue queue;
9      private TextMessage msg;
10
11     // creates a connection to the WLS using a JNDI context
12     public void init(Context ctx, String queueName) throws NamingException, JMSException {
13
14         // creates connection factory based on JNDI and a connection, creates a session
15         qconFactory = (QueueConnectionFactory) ctx.lookup(Config.JMS_FACTORY);
16         qcon = qconFactory.createQueueConnection();
17         qsession = qcon.createQueueSession(false, Session.AUTO_ACKNOWLEDGE);
18
19         // lookups the queue using the JNDI context
20         queue = (Queue) ctx.lookup(queueName);
21
22         // create sender and message
23         qsender = qsession.createSender(queue);
24         msg = qsession.createTextMessage();
25     }
26
27     // close sender, connection and the session
28     public void close() throws JMSException {
29         qsender.close(); qsession.close();
30         qcon.close();
31     }
```

JMS Producer Example (2)

```
32 // sends the message to the queue
33 public void send(String queueName, String message) throws Exception {
34     // create a JNDI context to lookup JNDI objects (connection factory and queue)
35     Hashtable env = new Hashtable();
36     env.put(Context.INITIAL_CONTEXT_FACTORY, Config.JNDI_FACTORY);
37     env.put(Context.PROVIDER_URL, Config.PROVIDER_URL);
38
39     InitialContext ic = new InitialContext(env);
40     init(ic, queueName);
41
42     // send the message and close
43     try {
44         msg.setText(message);
45         qsender.send(msg, DeliveryMode.PERSISTENT, 8, 0);
46         System.out.println("The message was sent to the destination " +
47             qsender.getDestination().toString());
48     } finally {
49         close();
50     }
51 }
52
53 public static void main(String[] args) throws Exception {
54     // JNDI name of the queue and a text message
55     String msg = args[0];
56     String queueName = args[1];
57
58     // create the producer object and send the message
59     JMSProducer producer = new JMSProducer();
60     producer.send(msg, queueName);
61 }
62 }
```

JMS Producer Example (3)

- Send a message to the queue
 - *You need to create a VPN connection to the environment*
 - *JMS Producer connects to the cluster*
(or one of the managed servers in the cluster)
 - *Arguments: (1) JNDI name of the queue, and (2) text message*
 - **/jms/mdw-queue** *or* **/jms/mdw-dist-queue**

```
1 | $ ./jmsproducer.sh /jms/mdw-queue message_from_mdw_lecture
2 | $ The message was sent to the destination mdw-module!mdw-queue
```


Monitor the JMS Queue

- How many messages
 - *Messages current*
 - number of messages in the queue waiting to be processed (**backlog**)
 - *Messages pending*
 - number of messages being processed (either being sent by a producer or being received by a consumer). Such messages have not been committed (acknowledged)

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JMS Consumer Example (1)

```
1  public class JMSConsumer implements MessageListener {
2
3      // connection factory
4      private QueueConnectionFactory qconFactory;
5
6      // connection to a queue
7      private QueueConnection qcon;
8
9      // session within a connection
10     private QueueSession qsession;
11
12     // queue receiver that receives a message to the queue
13     private QueueReceiver qreceiver;
14
15     // queue where the message will be sent to
16     private Queue queue;
17
18     // callback when the message exist in the queue
19     public void onMessage(Message msg) {
20         try {
21             String msgText;
22             if (msg instanceof TextMessage) {
23                 msgText = ((TextMessage) msg).getText();
24             } else {
25                 msgText = msg.toString();
26             }
27             System.out.println("Message Received: " + msgText);
28         } catch (JMSException jmse) {
29             System.err.println("An exception occurred: " + jmse.getMessage());
30         }
31     }
```

JMS Consumer Example (2)

```
32 // create a connection to the WLS using a JNDI context
33 public void init(Context ctx, String queueName)
34     throws NamingException, JMSException {
35
36     qconFactory = (QueueConnectionFactory) ctx.lookup(Config.JMS_FACTORY);
37     qcon = qconFactory.createQueueConnection();
38     qsession = qcon.createQueueSession(false, Session.AUTO_ACKNOWLEDGE);
39     queue = (Queue) ctx.lookup(queueName);
40
41     greceiver = qsession.createReceiver(queue);
42     greceiver.setMessageListener(this);
43
44     qcon.start();
45 }
46
47 // start receiving messages from the queue
48 public void receive(String queueName) throws Exception {
49     Hashtable env = new Hashtable();
50     env.put(Context.INITIAL_CONTEXT_FACTORY, Config.JNDI_FACTORY);
51     env.put(Context.PROVIDER_URL, Config.PROVIDER_URL);
52
53     InitialContext ic = new InitialContext(env);
54     init(ic, queueName);
55
56     System.out.println("Connected to " + queue.toString() + ", receiving messages...");
57
58     // loop until ctrl+c
59     while (true) {
60         this.wait();
61     }
62 }
```

JMS Consumer Example (3)

- Receive a message from the queue
 - *You need to create a VPN connection to the environment*
 - *JMS Consumer connects to the cluster*
(or one of the managed servers in the cluster)
 - *Arguments: (1) JNDI name of the queue*
 - **/jms/mdw-queue or /jms/mdw-dist-queue**

```
1 $ ./jmsconsumer.sh /jms/mdw-queue
2 $ Connected to mdw-module!mdw-queue, receiving messages...
3   Message Received: message-from-mdw-lecture1
4   Message Received: message-from-mdw-lecture2
```

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Error Handling Using Timeout

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- *message consumers or message processing may fail*
- ***visibility timeout** – time during which the message exist in the queue, and need to be deleted by the consumer (~ 30 seconds)*
- *Example technology: Amazon Simple Queue Service (SQS)*

Error Handling Using Transactions

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- ***transaction*** – message consumer opens a transaction and deletes the message; when the processing is successful the transaction is committed otherwise it is rolled back and the message appears in the queue again
- *Example technology: JMS, Weblogic server*

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Publish/Subscribe System

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- *occurrence of a message = event that triggers one or more processes*
- *a "1 : N" relationship between producer and consumer*
 - ***one message can be processed by many different subscribers***
- ***time-dependency** between publisher and subscriber*
 - *subscriber must first subscribe to a topic and then publisher can publish a message under that topic*
- *a message is deleted when all its subscribers consume it*

Publish/Subscribe API

- **lookupTopic**
 - *looks up or creates a topic*
 - *called by the subscriber first and then by the publisher*
- **receiveMessage**
 - *request to receive (read) a message under the topic*
 - *called by the subscriber*
 - *Implementation specific:*
 - *synchronous – blocking, with timeout*
 - *asynchronous – through event listener*
- **publishMessage**
 - *publishes a message under the topic*
 - *called by the publisher*

Event-driven Communication

- Event
 - *Occurrence of a message with certain topic*
- Event-driven Process
 - *events trigger actions*
 - *one event may trigger more actions*
 - *loose coupling – not all actions need to be known at design time*

Event-driven Process Example

- Conceptual process

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- Event-driven process implementation

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Overview

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- Store and Forward

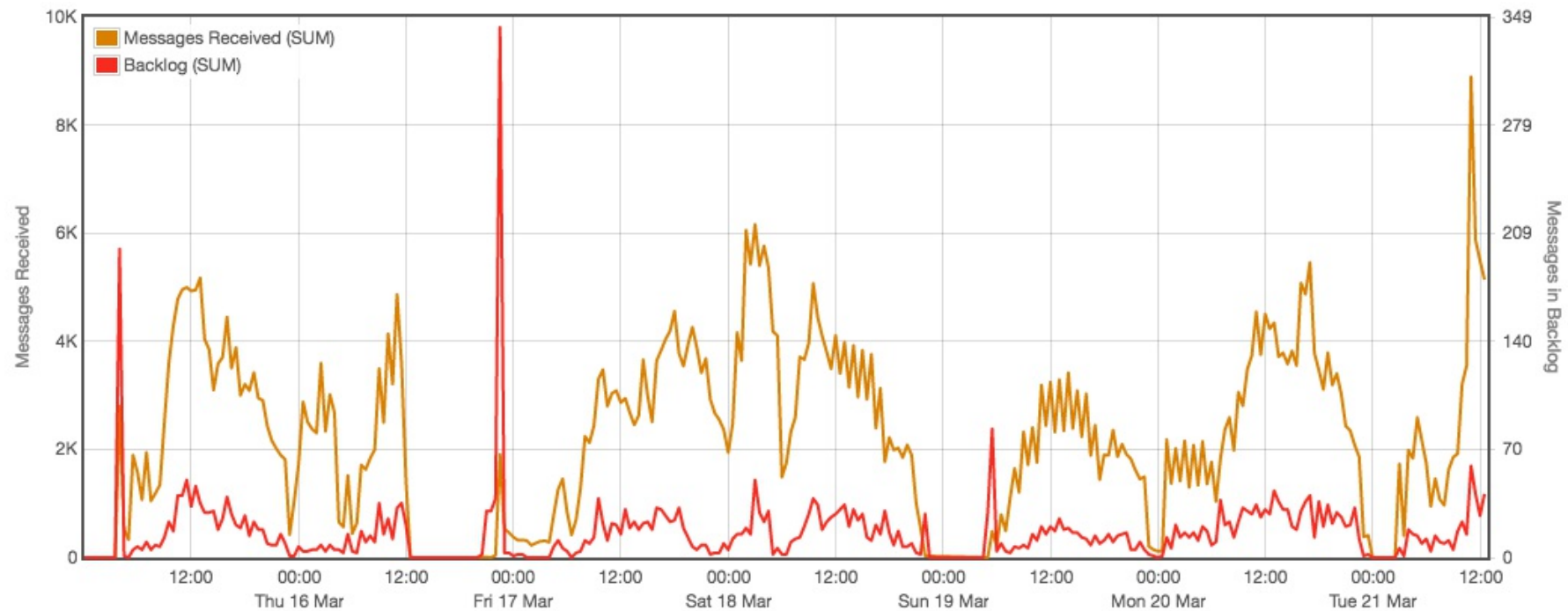
Store and Forward Agents

- Motivation
 - *Several environments (integration middleware, OSM, CRM)*
 - *Sending messages across environments*
 - *A need to "decouple" environments*
 - *Destination (queue) might not be always available*
 - *Destination environment is down or busy*
- SAF = Store and Forward
 - *Agent – a component deployed to an application server instance*
 - *has a queue and its own storage*
 - *has configured a remote destination*
- Scenario
 1. *JMS producer sends a message to the agent's queue*
 2. *Agent forwards the message to the remote destination*
 3. *When the remote destination is not available, the agent keeps the message in its queue and retries to send the message after some time*
 4. *As a result of the unavailability, there can be a **backlog** of messages in the agent's queue*

Example SAF Agent Architecture



Example SAF Agent Backlog



- Messages received
 - number of messages received to the SAF agent queue in every hour
- Backlog
 - number of messages waiting to be sent across to the destination queue
 - Destination system cannot catch up with number of messages being sent across