ID2208 Programming Web Services

Web Services and Stateful Resources

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This lecture reference

Text-book **Building Web Services with Java: Making Sense of XML, SOAP, WSDL, and UDDI, 2nd Edition**

Chapter 8

States and Services

- A *stateless service* –message exchange without access to information not contained in the message

- A *service that acts upon stateful resources* – allows access or modification to stateful resources based on messages it sends or receives

Web services and State

- Web services are best modeled as stateless message processors
- States - data values that persist across, and evolve as a result of, Web service interactions.
- States – piece of information outside the content of WS messages which is needed to process the request
- Stateful resources – the information that forms the state
- We need to define conventions for managing state so that applications discover, inspect, and interact with stateful resources in standard and interoperable ways

Stateful resources

- have a set of data which are expressible as XML documents
- have a clearly defined life-cycle
- are known by some Web services which act upon them
- can be a collection of other stateful resources

Stateful resources aspects

- Identification of stateful resources
- Creation of stateful resources
- How to send messages to stateful resources
- Modification/updating stateful resources
- Termination of stateful resources

WS-Resources

- A stateful resource is associated with Web service
  - Web service provides a platform for sending messages to resources
  - stateful resource represents an identifiable unit of state information
- A Web service can be responsible for processing messages related to many WS-Resources (one-to-many relationship)
- Singleton pattern – one-to-one relationship between Web service and stateful resource
- WS-Resource can be associated with many Web services (many-to-one relationship)

WS-Addressing

- WS-Addressing standardizes the endpoint reference construct (the notion of pointer to Web service) that is used to represent the address of a Web service deployed at a given network endpoint
- WS-Addressing endpoint reference is an XML serialization of a network-wide *pointer* to a Web service (together with SOAP binding describing how WS-Addressing is used in applications)
- The endpoint reference contains
  - Endpoint address of the Web service
  - Some other metadata related to Web service (description information and reference properties)

WS-Addressing

```
<wsa:EndpointReference
 xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
 xmlns:wsp="http://schemas.xmlsoap.org/ws/2002/12/policy"
 xmlns:tns="http/www.skatestown.com/services/StockAvailableNotification">
   <wsa:Address>
        http:/www.skatestown.com/services/StockAvailableNotification
   </wsa:Address>
   <wsa:PortType>
        tns:StockAvailableNotificationPortType
   </wsa:PortType>
   <wsa:ServiceName PortName="StockAvailableNotification">
        tns:StockAvailableNotification
   </wsa:ServiceName>
   <wsa:Policy >.   .   .
   <wsa:ReferenceProperties>
        <tns:resourceID> C </tns:resourceID>
   </wsa:ReferenceProperties>
</wsa:EndpointReference>
```

WS-Addressing and SOAP Header

- **`To`** – destination header – copy of the content of the **`Address`** element in the endpoint reference
- **`From`** – endpoint reference of message creator
- **`ReplyTo`** – to whom reply should be sent
- **`Recipient`** – contains a copy of the endpoint reference of the Web service that is intended recipient of the message
- **`FaultTo`** – whom to send fault message
- **`Action`** – contains URI indicating the intent of the message
- **`MessageID`** – URI uniquely identifying the message
- **`RelatesTo`** – collection of QNames and URIs to specify relationship beween this message and other messages (domain specific)

WS-Addressing Usage

```
<soap12:Envelope
 xmlns:soap12=http://www.w3.org/2002/12/soap-envelope"
 xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
 xmlns:tns="http://www.skatestown.com/services/StockAvailableNotification">
 <soap12:header>
   <wsa:To>
        http://www.skatestown.com/services/StockAvailableNotification
   </wsa:To>
   <tns:resourceID> C </tns:resourceID>
   <wsa:Action>
   http://www.skatestown.com/services/StockAvailableNotification#registration
   </wsa:Action>
   . . .
  </soap12:header>
  <soar12:Body>
   <ns2:registration …>
   . . .
  </soar12:Body>
</soap12:Envelope>
```

Web services and Stateful Resources

- Implied resource pattern – a set of conventions on Web services technologies
- Implied resource pattern refers to the mechanism which associates the resources with execution of message exchanges in Web services
- The conventions allow the state of a resource that participates in the implied resource pattern to be defined and associated with the description of a Web service interface.

WS-Resource identity

- WS-Resource is identified through the stateful resource identifier that is carried in the reference properties component
- WS-Resource-qualified endpoint reference can be used to direct requests to the WS-Resource
- The requests go through the Web service component of the WS-Resource

WS-Resource identity

- Service requestor should not examine or attempt to interpret the contents of the reference properties
- For service requestor the content of reference properties is opaque
- Meaning of the identity of stateful resource is WS-Resource implementation dependent
- Requestor may pass endpoint reference to other services

WS-Resource in WSDL

Returns invoice:

```
<message name="poSubmissionRequest">
   <part name="purchaseOrder" element="po:po"/>
</message>
<message name="poSubmissionResponse">
   <part name="invoice" element="inv:invoice">
</message>

<portType name="poSubmissionPortType">
   <operation name="doSubmission">
        <input message="pos: poSubmissionRequest"/>
        <output message="pos: poSubmissionResponse"/>
   </operation>
</portType>
```

Returns WS-Resource:

```
<message name="poSubmissionResponse">
   <part name="poEPR" element="pos:POReference">
</message>
```

where

```
<xsd:element name="POReference" type="wsa:EndpointReferenceType"/>
```

WS-Resource in WSDL

```
<soap:Envelope . . .>
   <soap:Header>. . .
   <soap:Body>
     <poRP:POReference>
                <wsa:Address>
                       http://www.skatestown.com/services/PO
                </wsa:Address>
                <wsa:ReferenceProperties>
                <poRP:POResourceID>453765</poRP:POResourceID>
                </wsa:ReferenceProperties>
                <wsa:PortType>poRP:POPortType</wsa:PortType>
                . . .
     </poRP:POReference>
   </soap:Body>
</soap:Envelope>
```

Resource property

- WS-Resource represents a state in Web service context
- The state has components - resource property elements
- Set of property elements – resource property document
- The WS-Resource has an XML *resource property document* defined using XML schema.
- Service requestors may determine a WS-Resource's type by retrieving the WSDL portType definition by standard means.
- Service requestors may use Web services message exchanges to read, modify, and query the XML document representing the WS-Resource's state.

Resource Property Document Schema (SkatesTown)

```
<xsd:schema
 xmlns:poRP="http://www.skatestown.com/ns/poResourceProperties"
 xmlns:po="http://www.skatestown.com/ns/po"... >
 <xsd:import namespace="http://www.skatestown.com/ns/po“schemaLocation=“./po.xsd"/>
 <xsd:element name=“dateReceived" type=“dateTime” />
 <xsd:element name=“status">
   <xsd:simpleType>
     <xsd:restriction base=“xs:string”>
      <xsd:enumeration value=“received” />
      <xsd:enumeration value=“posted” />
      <xsd:enumeration value=“pending” />
      <xsd:enumeration value=“invoiced” />
      <xsd:enumeration value=“completed” />
     </xsd:restriction>
   </xsd:simpleType>
 </xsd:element>
 <xsd:element name=“statusDate" type=“dateTime” />
 <xsd:element name=“contactPerson" type=“xs:string” />
 <xsd:element name=“poResourceProperties">
   <xsd:complexType>
    <xsd:sequence>
      <xsd:element ref=“po:po” minOccurs=“1” maxOccurs=“1” />
      <xsd:element ref=“poRP:dateReceived” minOccurs=“1” maxOccurs=“1”/>
      <xsd:element ref=“poRP:status” minOccurs=“1” maxOccurs=“1” />
      <xsd:element ref=“poRP:statusDate” minOccurs=“1” maxOccurs=“1” />
      <xsd:element ref=“poRP:contactPerson” minOccurs=“0” maxOccurs=“unbound” />
    </xd:sequence>
   </xsd:complexType>
 </xsd:element>
…
</xsd:schema>
```

Resource Properties Document

```
<poRP:poResourceProperties
   xmlns:po="http://www.skatestown.com/ns/po“   xmlns:poRP="http://
   www.skatestown.com/ns/poResourceProperties“
   xmlns:xsi=“http://www.w3.org/2001/XMLSchema-instance”
   xsi:schemaLocation=“http://www.skatestown.com/ns/poResourceProperties
        http://www.skatestown.com/ns/po ./po.xsd”>
   <po:po id=“44581” submitted=“2004-06-05” customerID=“467836”>
        <billTo>
                <company>The Skateboard Warehouse</company>
                <street>One Warehouse Park, Building 17</street>
                <city>Boston</city>
                <state>MA</state>
                <postalCode>01775</postalCode>
        </billTo>
        <shipTo>
                <company>The Skateboard Warehouse</company>
                  . . .
        <order>
                <item sku=“316-BP” quantity=“5”>
                  <description>Skateboard backpack</description>
                </item>
                <item sku=“947-TI” quantity=“5”>
                  <description> Street-style titanium skateboard.
                  </description>
                </item>
        </order>
   </po:po>
. . .
   <poRP:dateReceived>2003-12-31T12:00:00</poRP:dateReceived>
   <poRP:status>received</poRP:status>
   <poRP:statusDate>2003-12-31T12:00:00</poRP:statusDated>
   <poRP:contactPerson>Jane Smith</poRP:contactPerson>
   <poRP:contactPerson>Mark Jonsson</poRP:contactPerson>
<poRP:poResourceProperties>
```

Resource Property Operations

```
<!-- Port type definitions -->
 <wsdl:portType name="POPortType"
      wsrp:ResourceProperties="poRP:poResourceProperties">
  <wsdl:operation name="getInvoice">
   <wsdl:input name="GetInvoiceRequest"
              message="poRP:GetInvoiceRequest" />
   <wsdl:output name="GetInvoiceResponse"
              message="poRP:GetInvoiceResponse" />
   <wsdl:fault name="NoInvoiceFault"
              message="poRP:ErrorMessage" />
  </wsdl:operation>
. . .

<!--  extends wsrp:GetResourceProperty ============ -->

  <wsdl:operation name="GetResourceProperty">
   <wsdl:input  name="GetResourcePropertyRequest"
      message="wsrp:GetResourcePropertyRequest" />
   <wsdl:output name="GetResourcePropertyResponse"
      message="wsrp:GetResourcePropertyResponse" />
   <wsdl:fault  name="ResourceUnknownFault"
      message="wsrp:ResourceUnknownFault" />
   <wsdl:fault  name="InvalidResourcePropertyQNameFault"
      message="wsrp:InvalidResourcePropertyQNameFault" />
  </wsdl:operation>
. . .
```

Retrieving the resource property

```
<soap:Envelope
   xmlns:soap=http://www.w3.org/2002/12/soap-envelope”
   xmlns:wsa=“http://schemas.xmlsoap.org/ws/2003/03/addressing”
   xmlns:wsrp=“http://www.ibm.com/xmlns/stdwip/web-services/WS-
   ResourceProperties”
   xmlns:poRP="http://www.skatestown.com/ns/poResourceProperties">
   <soap:Header>
        <wsa:To soap:mustUnderstand=“1”>
             http://www.skatestown.com/services/PO
        </wsa:To>
        <poRP:POResourceID>348374</poRP:POResourceID>
        <wsa:Action>
             http://www.ibm.com/xmlns/stdwip/web-services/WS-
                  ResourceProperties/GetResourceProperty
        </wsa:Action>
   </soap:Header>
   <soar:Body>
        <wsrp:GetResourceProperty>
             poRP:status
        </wsrp:GetResourceProperty>
   </soap:Body>
</soap:Envelope>
```

Reply to retrieving the resource property

```
<soap:Envelope
   xmlns:soap=http://www.w3.org/2002/12/soap-envelope”
   xmlns:wsa=“http://schemas.xmlsoap.org/ws/2003/03/addressing”
   xmlns:wsrp=“http://www.ibm.com/xmlns/stdwip/web-services/WS-
   ResourceProperties”
   xmlns:poRP="http://www.skatestown.com/ns/poResourceProperties">
   <soap:Header>
        <wsa:To soap:mustUnderstand=“1”>
             http://www.skateWarehouse.com/someEndpoint
        </wsa:To>
        <wsa:Action>
             http://www.ibm.com/xmlns/stdwip/web-services/WS-
                  ResourceProperties/GetResourcePropertiy
        </wsa:Action>
   </soap:Header>
   <soar:Body>
        <wsrp:GetResourcePropertyResponse>
             <poRP:status>received</poRP:status>
        </wsrp:GetResourcePropertyResponse>
   </soap:Body>
</soap:Envelope>
```

Request to retrieving the resource property

```
<soap:Envelope ...
 xmlns:wsrp="http://www.ibm.com/xmlns/stdwip/web-services/WS-
   ResourceProperties"
 xmlns:poRP="http://www.skatestown.com/ns/poResourceProperties">
 <soap:Header>
  <wsa:To soap:mustUnderstand="1">
            http://www.skatestown.com/services/PO
  </wsa:To>
  <poRP:POResourceID>348374</poRP:POResourceID>
  <wsa:Action> http://www.ibm.com/xmlns/stdwip/web-
      services/WS-ResourceProperties/GetResourceProperty
  </wsa:Action>
 </soap:Header>
 <soar:Body>
  <wsrp:GetMultipleResourceProperty>
   <wsrp:ResourceProperty>poRP:status</wsrp:ResourceProperty>
   <wsrp:ResourceProperty>poRP:statusData</wsrp:ResourceProperty>
   <wsrp:ResourceProperty>poRP:contactPerson</wsrp:ResourceProperty>
  </wsrp:GetResourceProperty>
 </soap:Body>
</soap:Envelope>
```

Reply to retrieving the resource property

```
<soap:Envelope . . .>
  <soap:Header>
   <wsa:To soap:mustUnderstand="1">
           http://www.skateWarehouse.com/someEndpoint
   </wsa:To>
   <wsa:Action>
    http://www.ibm.com/xmlns/stdwip/web-services/WS-
            ResourceProperties/GetResourcePropertiy
   </wsa:Action>
  </soap:Header>
  <soar:Body>
   <wsrp:GetMultipleResourcePropertyResponse>
    <poRP:status>received</poRP:status>
    <poRP:statusDate>2003-12-31T12:00:00 </poRP:statusDate>
    <poRP:contactPerson>Jane Smith</poRP:contactPerson>
    <poRP:contactPerson>Mark Jonsson</poRP:contactPerson>
   </wsrp:GetResourcePropertyResponse>
  </soap:Body>
</soap:Envelope>
```

Resource Property Operations

```
<!-- ======= extends wsrp:QueryResourceProperties ========== -->
<wsdl:operation name="QueryResourceProperties">
  <wsdl:input  name="QueryResourcePropertiesRequest"
       message="wsrp:QueryResourcePropertiesRequest" />
  <wsdl:output name="QueryResourcePropertiesResponse"
       message="wsrp:QueryResourcePropertiesResponse" />
  <wsdl:fault  name="ResourceUnknownFault"
       message="wsrp:ResourceUnknownFault" />
  <wsdl:fault  name="InvalidResourcePropertyQNameFault"
       message="wsrp:InvalidResourcePropertyQNameFault" />
  <wsdl:fault  name="UnknownQueryExpressionDialectFault"
       message="wsrp:UnknownQueryExpressionDialectFault" />
  <wsdl:fault  name="InvalidQueryExpressionFault"
       message="wsrp:InvalidQueryExpressionFault" />
  <wsdl:fault  name="QueryEvaluationErrorFault"
       message="wsrp:QueryEvaluationErrorFault" />
</wsdl:operation>
```

```
<soap:Envelope
. . .
  <poRP:POResourceID>362762</poRP:POResourceID>
 </soap:Header>
 <soar:Body>
   <wsrp:QueryResourcePropertiesRequest>
    <wsrp:QueryExpression dialect=
                        “http://www.w3.org/TR/1999/REC-xpath-19991116”>
              ./poRP:status=“pending”
    </wsrp:QueryExpression>
   </wsrp:QueryResourcePropertiesRequest>
 </soap:Body>
</soap:Envelope>
```

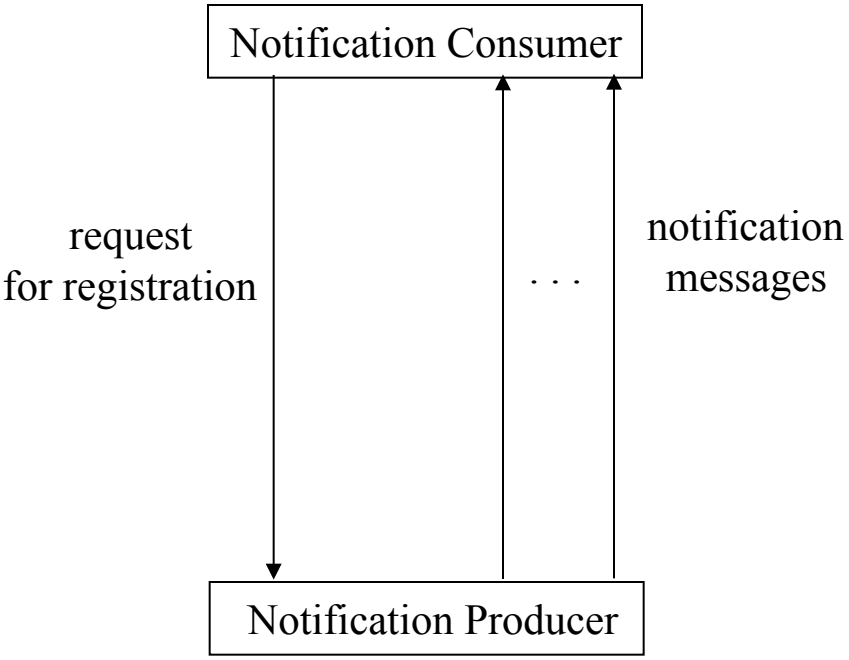
Set Resource Properties (**Insert, Update, Delete**)

```
. . .
<poRP:POResourceID>362762</poRP:POResourceID>
. . .
<wsrp:SetResourceProperties>
 <wsrp:Delete ResourceProperty="poRP:contactPerson">
 </wsrp:Delete>
 <wsrp:Insert>
  <poRP:contactPerson>Julia James</poRP:contactPerson>
 </wsrp:Insert>
 <wsrp:Update>
  <poRP:status>posted</poRP:status>
 </wsrp:Update>
</wsrp:SetResourceProperties>
. . .
```

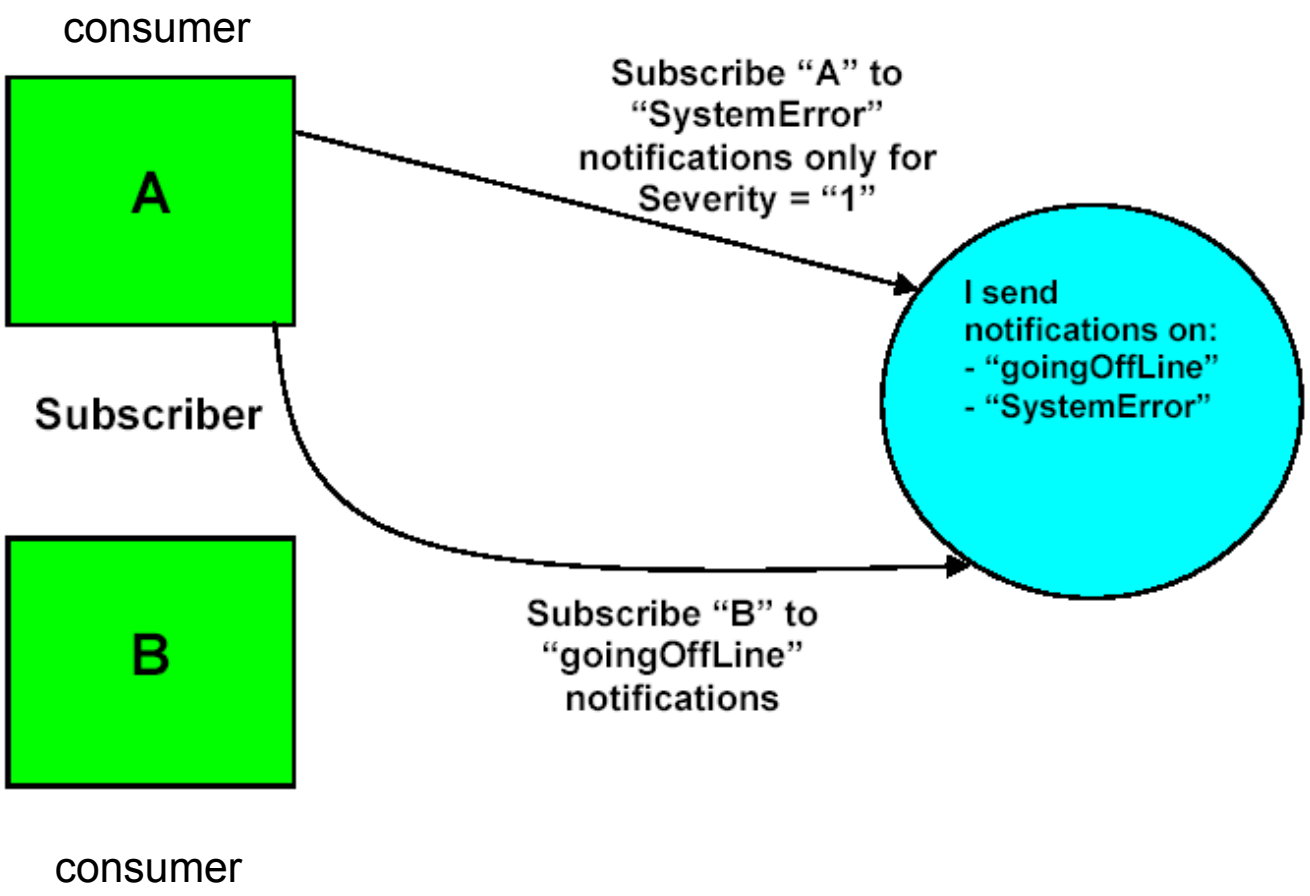
WS-Notification

- Publish-Subscribe Notification for Web services
- WS-BaseNotification
- WS-Topics
- WS-BrokeredNotification

WS-Notification



WS-Notification (subscription)



http://www-106.ibm.com/developerworks/library/ws-pubsub/WS-PubSub.pdf

Notification

```
<!-- extends wsnt:NotificationProducer ============= -->

<wsdl:operation name="Subscribe">
   <wsdl:input  message="wsnt:SubscribeRequest" />
   <wsdl:output message="wsnt:SubscribeResponse" />
   <wsdl:fault name="ResourceUnknownFault"
       message="wsnt:ResourceUnknownFault" />
  <wsdl:fault name="SubscribeCreationFailedFault"
       message="wsnt:SubscribeCreationFailedFault"/>
   <wsdl:fault name="TopicPathDialectUnknownFault"
       message="wsnt:TopicPathDialectUnknownFault"/>
</wsdl:operation>
. . .
```

Subscribe

```
. . .
<wsnt:Subscribe>
   <wsnt:ConsumerReference>
        wsa:endpointReference
   </wsnt:ConsumerReference>
   <wsnt:TopicExpression dialect = “xsd:anyURI”>
        {any}
   </wsnt:TopicExpression>
   <wsnt:UseNotify> xsd:boolean </wsnt:UseNotify>?
   <wsnt:Precondition> wsrp:QueryExpression </Precondition>?
   <wsnt:Selector> wsrp:QueryExpression </wsnt:Selector>?
   <wsnt:SubscriptionPolicy> {any} </wsnt:SubscriptionPolicy>?
   . . .
</wsnt: Subscribe>
. . .
```

WS-Notification (subscribe)

```
<soap:Envelope xmlns:wsnt="http://www.ibm.com/xmlns/stdwip/web-
   services/WS-BaseNotfication"
. . .
   <soap:Header>
      <wsa:Action>
        xmlns:wsnt="http://www.ibm.com/xmlns/stdwip/web-services/WS-
        BaseNotfication/Subscribe"
      </wsa:Action>
. . .
      <poRP:POResourceID>362762</poRP:POResourceID>
   </soap:Header>
   <soap:Body>
    <wsnt:Subscribe>
        <wsnt:ConsumerReference>
           <wsnt:Address>
        http://www.skateboardwarehouse.com/services/inventoryManagement
           </wsnt:Address>
        </wsnt:ConsumerReference>
        <wsnt:TopicExpression Dialect="http://www.ibm.com/
          xmlns/stdwip/web-services/WS-Topics/TopicExpression/simple">
           poRP:status
        </wsnt:TopicExpression>
        . . .
    </wsnt:Subscribe>
. . .
```

WS-Notification (response)

```
…
<wsnt:SubscribeResponse>
   <wsnt:SubscriptionReference>
        <wsa:Address>
                Address of Subscription Manager
     </wsa:Address>
        <wsa:ReferenceProperties>
                Subscription Identifier
        </wsa:ReferenceProperties>
   …
   </wsnt:SubscriptionReference>
…
</wsnt:SubscribeResponse>
…
```

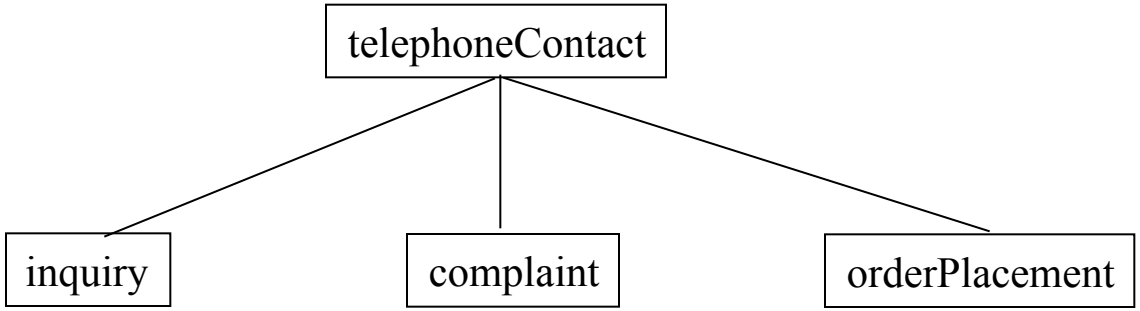
Subscription Resource Properties

```
<xsd:element name="ConsumerReference"
   type="wsa:EndpointReferenceType"
   minOccurs="1" maxOccurs="1" />
<xsd:element name="TopicExpression"
   type="wsnt:TopicExpressionType"
   minOccurs="1" maxOccurs="1" />
<xsd:element name="UseNotify" type="xsd:boolean"
   minOccurs="1" maxOccurs="1" />
<xsd:element name="Precondition"
   type="wsrp:QueryExpressionType"
   minOccurs="0" maxOccurs="1" />
<xsd:element name="Selector"
   type="wsrp:QueryExpressionType"
   minOccurs="0" maxOccurs="1" />
<xsd:element name="SubscriptionPolicy" type="xsd:anyType"
   minOccurs="0" maxOccurs="1" />
<xsd:element name="CreationTime" type="xsd:dateTime"
   minOccurs="0" maxOccurs="1" />
<xsd:element name="CurrentTime" type="xsd:dateTime"
   minOccurs="0" maxOccurs="1" />
<xsd:element name="TerminationTime" type="xsd:dateTime"
   minOccurs="0" maxOccurs="1" />
. . .
```

WS-Topics

- Notification messages can be organized and categorized as a collection of related Topics
- When a Subscriber creates a Subscription, it associates the Subscription with one or more Topics
- The NotificationProducer uses the Topic lists as part of the matching process
- Set of Topics associated with a given XML Namespace is termed a *Topic Space*
- Topics can be organized in a hierarchical way

Topics

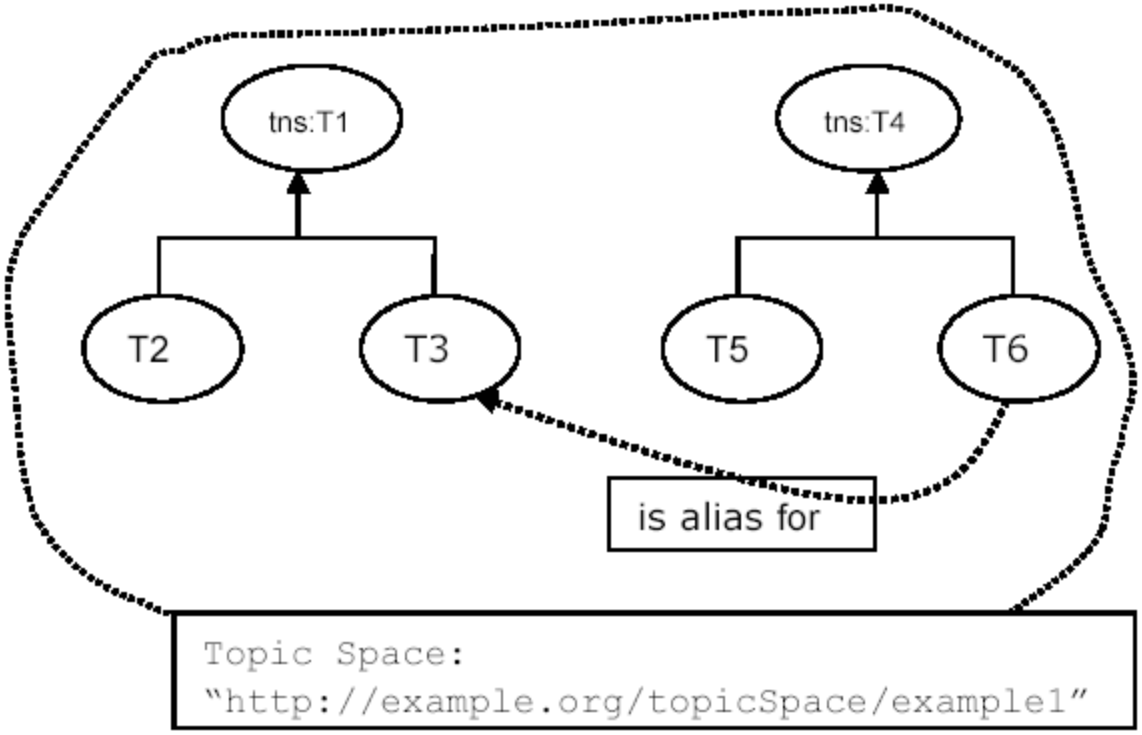



```
<wstop:topic name="telephoneContact">
  <wstop:topic name="inquiry" . . ./>
  <wstop:topic name="complaint" . . ./>
  <wstop:topic name="orderPlacement" . . ./>
</wstop:topic>
```

Topics

```
<wstop:topic name="telephoneContact">
  <wstop:topic name="inquiry"
      messageTypes="crm:inquiryNotification"/>
  <wstop:topic name="complaint"
          messageTypes="crm:complaintNotification final="false">
    <wstop:documentation>
        Note that all complaints appear in this topic
    </wstop:documentation>
     <wstop:topic name="VIPComplaint"
       messageTypes="crm:complaintNotification final="false"/>
      <wsrp:QueryExpression
       dialect="http://www.w3.org/TR/1999/REC-xpath-19991116">
         boolean(/*/customer/@customerStatus="vip")
      </wsrp:QueryExpression>
      <tns:VIPHotLine>555-1212</tnsVIPHotLine>
  </wstop:topic>
                ...
  <wstop:topic name="orderPlacement">
      <wstop:AliasRef dialect="http://www.ibm.com/xmlns/stdwip/
       web-services/WS-Topics/TopicExpression/concreteTopicPath">
       crm:orderContact
      </wstop:AliasRef>
  </wstop:topic>
. . .
```

Topic Spaces



http://www-106.ibm.com/developerworks/library/ws-pubsub/WS-PubSub.pdf

Dynamic Topics

- Circumstances under which a NotificationProducer MAY add new child Topics to a Topic:
  - a Subscriber attempting to subscribe to a TopicExpression that suggests a new child Topic;
  - a Publisher attempting to publish to a TopicExpression that suggests a new child Topic;
  - the NotificationProducer implementation encountering a new circumstance that doesn't fit well with any of the existing child Topics;
  - an administrator explicitly adding support for a new child Topic using some administrative portType implemented by the NotificationProducer.
- Ad Hoc Topic space:
  - ad-hoc TopicSpace has no pre-defined root Topics, but allows new root Topics to be added dynamically
  - Any Topic that is added dynamically to the ad-hoc TopicSpace itself permits the addition of further child Topics
  - A NotificationProducer or Subscriber can use this TopicSpace to define *ad-hoc Topics* dynamically, without having to associate them with their own TopicSpace.

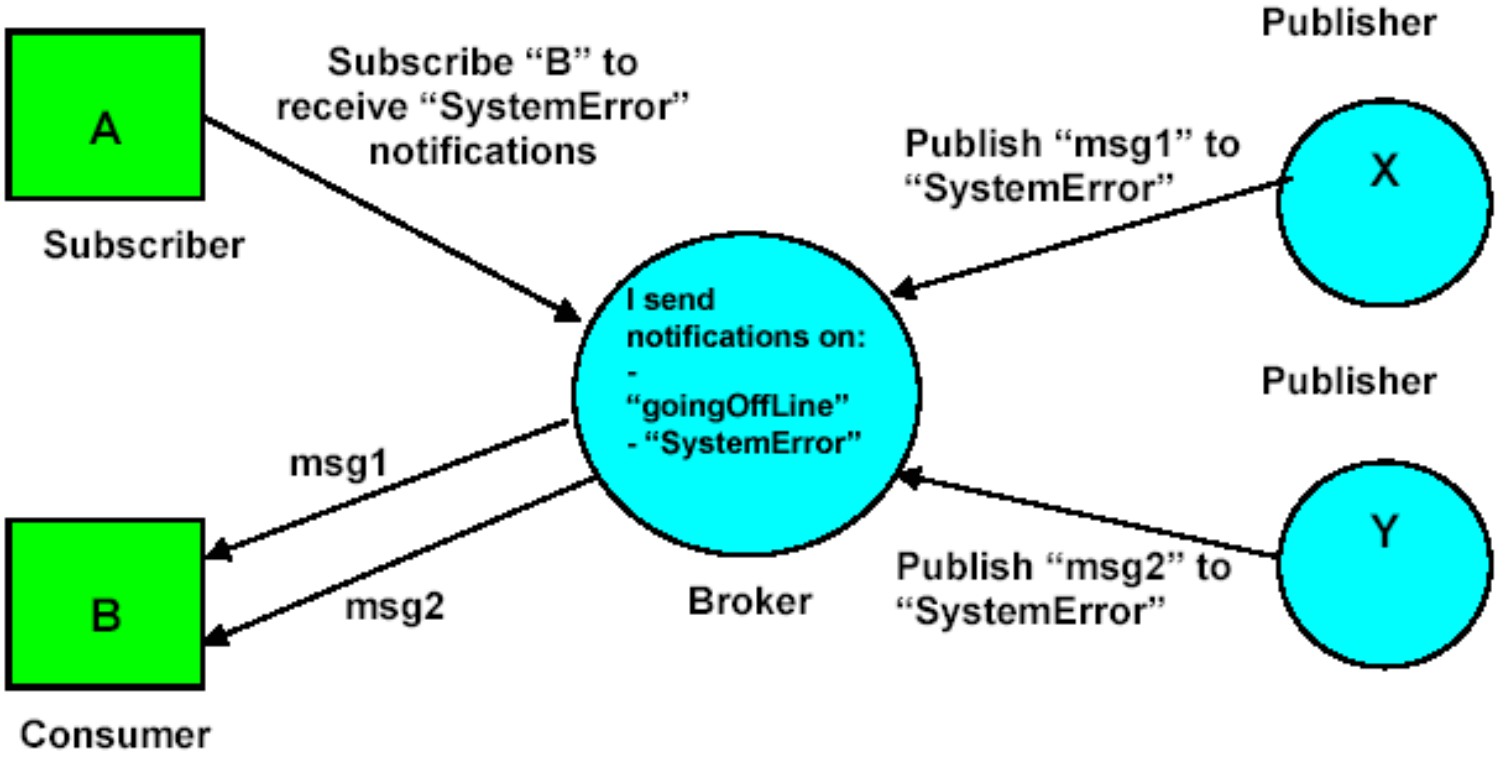
Value Changes Notification

- Each resource property has a corresponding topic
- Web service of the WS-Resource component must support operations from **`NotificationProducer portType`** and include topics from resource property
- For all topics associated with resource property value change the notification message contains **`ResourcePropertyValueChangeNotification`** element containing:
  - **`oldValue`**
  - **`newValue`**

Value Changes Notification

```
<wsnt:Subscribe>
  <wsnt:ConsumerReference>
    <wsnt:Address>http://www.skateboardwarehouse.com/services
      /inventoryManagement
    </wsnt:Address>
  </wsnt:ConsumerReference>
  <wsnt:TopicExpression
    dialect=xmlns:wsnt="http://www.ibm.com/xmlns/stdwip/
            web-services/WS-Topics/TopicExpression/simple">
        poRP:status
  </wsnt:TopicExpression>
  <wsnt:Selector dialect="http//www.w3.org/TR/
            1999/REC-xpath-19991116">
      boolean(/*/wsrp:OldValue/poRP:status/="received" and
              /*/wsrp:NewValue/poRP:status="posted")
  </wsnt:Selector>
      . . .
</wsnt:Subscribe>
```

Notification Brokers



http://www-106.ibm.com/developerworks/library/ws-pubsub/WS-PublishS.pdf

Scheduled Destruction

- **`CurrentTime`** and **`TerminationTime`** can be retrieved by **`GetResourceProperties`** operations
- **`TerminationTime`** can be in future or in past relative to current time
- New termination time value (via **`SetTerminationTime`**) can be accepted by managing resource Web service or not

Notification of Destruction

- There is a standardized topic in the namespace ResourceTermination

```
<wsnt:Subscribe>
          . . .
  <wsnt:TopicExpression dialect="http://www.ibm.com/xmlns
     /stdwip/web-services/WS-Topic/TopicExpression/simple">
          wsrl:ResourceTermination
  </wsnt:TopicExpression>
  . . .
```

- Notification message

```
<wsrl:TerminationNotification>
  <wsrl:TerminationTime>xsd:dateTime</wsrl:TerminationTime>
  <wsrl:TerminationReason>xsd:any</wsrl:TerminationReason>
</wsrl:TerminationNotification>
```

Next lecture

- Semantic Web Services

Lecture Notes only