Business Process Digitalization and Cloud Computing

14. Advanced BPEL

Andrea Morichetta, Phd

January 12, 2017

Computer Science Division

slides are based on the WS-BPEL 2.0 for SOA Composite Applications with Oracle SOA Suite

Table of contents

1. Loops
2. Delays
3. Faults
4. Sopes
5. Compensation
6. Events
7. Event Handler
8. Business process lifecycle
9. Correlation and message properties
10. Dynamic Partner Links
11. Building BPEL application Using JDeveloper
12. Deploy

Recap

In the previous part we saw:

- Operation `<invoke>`, `<receive>`, `<reply>`
- Declaring variables `<variable>`
- Updating variable contents `<assign>`
- Structured activities `<sequence>`, `<flow>`
- Conditional behaviour `<if>`

Loops

Loops

BPEL supports the following three types of loop:

- `<while>`
- `<repeatUntil>`
- `<forEach>` provide the possibilities to start instances in parallel

Loops are useful for using arrays.

Arrays can be simulated using XML schema complex type.

While

- **Repeat the enclosed activity** until the boolean condition no longer holds true.
- The **Boolean condition** is expressed through the condition element, using the selected expression language

```
<while>
   <condition> boolean-expression </condition>
   <!-- Perform an activity or a set of activities enclosed by
     <sequence>,
     <flow>, or other structured activity -->
</while>
```

While example

Lets consider the possibility to **check the flight availability** for **more than one person**.

```
<while>
  <condition>$Counter &lt; $NoOfPassengers</condition>
  <sequence>
    <!-- Construct the FlightDetails variable with passenger data-->
    ...
    <!-- Invoke the web service -->
    <invoke partnerLink="AmericanAirlines"
      portType="aln:FlightAvailabilityPT"
      operation="FlightAvailability"
      inputVariable="FlightDetails" />
    <receive partnerLink="AmericanAirlines"
      portType="trv:FlightCallbackPT"
      operation="FlightTicketCallback"
      variable="FlightResponseAA" />
    ...
    <!-- Process the results ... -->
    ...
    <!-- Increment the counter -->
    <assign>
      <copy>
        <from>$Counter + 1</from>
        <to variable="Counter"/>
      </copy>
    </assign>
  </sequence>
</while>
```

Repeat Until

The <repeatUntil> loop repeats the enclosed activities **until the Boolean condition remains true**.

```
< repeatUntil >
   <!-- Perform an activity or a set of activities enclosed by <sequence>, <flow>,
          or other structured activity -->
   <condition> boolean-expression </condition>
</ repeatUntil >
```

For each loop

- The `<forEach>` loop is a **for type loop**
- Can execute the loop **branches in parallel or serial** (The first one is very similar to the **for** the latter is similar to **flow**)
- Requires to specify the variable for counter (`startCounterValue, finalCounterValue`)
- Requires that all the activities executed within the branch should be **grouped into a** `<scope>`
- The loop will complete when **all branches have completed**.

```
<forEach counterName="BPELVariableName" parallel="yes|no">
   <startCounterValue>unsigned-integer-expression</startCounterValue>
   <finalCounterValue>unsigned-integer-expression</finalCounterValue>
   <scope>
      <!-- The activities that are performed within forEach have to be nested within a scope. -->
   </scope>
</forEach>
```

For each finish condition

- Could be useful if the `<foreach>` loop would **not have to wait for all branches to complete**
- We can specify that the loop will **complete after at least N branches** have completed
- Using the `<completionCondition>` we can specify the number N of `<branches>`
- Using the `successfulBranchesOnly` we can specify if we would like to count **only successful** or **all branches**.

```
<forEach counterName="BPELVariableName" parallel="yes|no">
  <startCounterValue>unsigned-integer-expression</startCounterValue>
  <finalCounterValue>unsigned-integer-expression</finalCounterValue>
  <completionCondition> <!-- Optional -->
    <branches successfulBranchesOnly="yes|no(default)">
      unsigned-integer-expression
    </branches>
  </completionCondition>
  <scope>
    <!-- The activities that are performed within forEach have to be nested within a scope. -->
  </scope>
</forEach>
```

Delays

Delays

Delays:

- for a specified **period of time**
- until a certain **deadline** is reached

Typically we could specify delays to invoke an operation at a **specific time** or **wait some time** and invoke the operation

We need to wait:

- **before to pool the results** of a previously initiated operation
- **between the iteration** of the pool

The Wait Activity into Delays

- **for** : We can specify **duration**; or a period of time.

```
<wait>
   <for> duration-expression </for>
</wait>
```

- **until** : We can specify a **deadline**; we specify a certain date and time.

```
<wait>
   <until> deadline-expression </until>
</wait>
```

Deadline Expression

The deadline data types are either **dateTime** or **date**.

The **lexical representation** should be conformed to the XPath

- C represents centuries
- Y represents years
- M represents months
- D represents days
- h represents hours
- m represents minutes
- s represents seconds
- Z is used to designate Coordinated Universal Time (UTC)
- T is used as time designator to indicate the start of the representation of the time.

```
<wait>
   <until>'2004-03-18T21:00:00+01:00'</until>
</wait>

<wait>
   <until>'18:05:30Z'</until>
</wait>
```

Duration Expressions

- P is used as the time duration designator. Duration expressions always start with P .
- Y follows the number of years.
- M follows the number of months or minutes.
- D follows the number of days.
- H follows the number of hours.
- S follows the number of seconds.

4 hours and 10 minutes

```
<wait>
   <for>'PT4H10M'</for>
</wait>
```

1 month, 3 days, 4 hours, and 10 minutes

```
<wait>
   <for>'P1M3DT4H10M'</for>
</wait>
```

1 year, 11 months, 14 days, 4 hours, 10 minutes, and 30 seconds

```
<wait>
   <for>'P1Y11M14DT4H10M30S'</for>
</wait>
```

Empty Activities

In BPEL process sometimes you need to specify activities for satisfying the XML Schema, but you **do not really want to perform any activities**.

For example `<if>` activity, require **to specify an activity for each branch**.

Not specifying an activity would result in an **error** so the solution is to specify an empty activity:

```
<empty/>
```

Ending a Process

The `<exit/>` activity **terminate a business process immediately** before the normal ending.

With the exit **no fault and compensation handling is performed**.

Faults

Fault handling and Signaling

BPEL **interact** with their partners through **operation invocations** of web services, so the typical faults are:

- The communication is over a **not highly reliable internet connection.**
- **Logical errors**
- **Execution errors** raised from defect on the infrastructure

So **fault handling and signaling** is an important aspect for business process **reliability**

Common Fault in BPEL

Possible faults:

- In a synchronous invocation, the operation might return a **WSDL fault message**.
- A process **explicitly signal** (throw) a fault
- **Automatic signal** generated by a join failure
- **Standard fault** (error condition in runtime environment, network communications etc)

WSDL faults

Fault in WSDL are **denoted by** `<fault>` **element** within the operation declaration.

In the Travel Process Example we can modify the travel approval operation:

```
<portType name="TravelApprovalPT">
  <operation name="TravelApproval">
    <input message="tns:TravelRequestMessage"/>
    <output message="aln:TravelResponseMessage"/>
  </operation>
</portType>
```

```
<message name="TravelFaultMessage">
  <part name="error" type="xs:string" />
</message>

<portType name="TravelApprovalPT">
  <operation name="TravelApproval">
    <input message="tns:TravelRequestMessage" />
     <output message="aln:TravelResponseMessage" />
     <fault name="fault" message="tns:TravelFaultMessage" />
  </operation>
</portType>
```

Signal throw

BPEL process may sometimes need to **explicitly signal a fault**.

```
<throw faultName="name">
```

BPEL **don't require a fault names in advance**, this approach can also be error-prone

Fault can also have **associated a variable** that contain **data related to the fault**.

```
<throw faultName="name" faultVariable="variable-name" />
```

Signaling Faults in synchronous reply

In synchronous invocation we can use the **reply activity to return a fault** instead of the output message.

In the travel example we can **add travelFaultMessage** starting from the definition of a new variable:

```
<variables>
  <!-- fault to the BPEL client -->
  <variable name="TravelFault" messageType="trv:TravelFaultMessage"/>
</variables>
```

Signaling fault in the synchronous travel example

```
<!-- Check if the ticket is approved -->
<if>
  <condition>
    $TravelResponse.confirmationData/aln:Approved='true'
  </condition>
  <!-- Send a response to the client -->
  <reply partnerLink="client"
        portType="trv:TravelApprovalPT"
        operation="TravelApproval"
        variable="TravelResponse"/>
  <else>
    <sequence>
          <!-- Create the TravelFault variable with fault description -->
      <assign>
          <copy>
            <from>string('Ticket not approved')</from>
            <to variable="TravelFault" part="error" />
          </copy>
        </assign>

        <!-- Send a fault to the client -->
        <reply partnerLink="client"
          portType="trv:TravelApprovalPT"
          operation="TravelApproval"
          variable="TravelFault"
          faultName="fault" />
      </sequence>
  </else>
</if>
```

```
<TravelFault>
  <part name="error">
    <error xmlns="http://packtpub.com/bpel/travel/">
      Ticket not approved
    </error>
  </part>
</TravelFault>
```

Signaling Faults in asynchronous scenario

- In the asynchronous scenario the fault is sent back using the **callback**.
- We define **additional callback** operation in the service WSDL using **the same port type**.

```
<message name="TravelFaultMessage">
  <part name="error" type="xs:string" />
</message>

<portType name="ClientCallbackPT">
  <operation name="ClientCallback">
    <input message="aln:TravelResponseMessage" />
  </operation>

  <operation name="ClientCallbackFault">
    <input message="tns:TravelFaultMessage" />
  </operation>
</portType>
```

The invoke callback operation

```
<!-- Check if the ticket is approved -->
<if>
    <condition>
      $TravelResponse.confirmationData/aln:Approved='true'
    </condition>
    <!-- Make a callback to the client -->
    <invoke partnerLink="client"
      portType="trv:ClientCallbackPT"
      operation="ClientCallback"
      inputVariable="TravelResponse" />
  <else>
    <sequence>
    <!-- Create the TravelFault variable with fault description -->
    <assign>
      <copy>
        <from>string('Ticket not approved')</from>
        <to variable="TravelFault" part="error" />
      </copy>
    </assign>

    <!-- Send a fault to the client -->
    <invoke partnerLink="client"
      portType="trv:ClientCallbackPT"
      operation="ClientCallbackFault"
      inputVariable="TravelFault" />
    </sequence>
  </else>
</if>
```

Handling Faults

- By means of a fault handler, the business process **defines custom activities** that are **used to recover the fault** and **recover the partial (unsuccessful) work** of the activity in which the fault has **occurred**
- The fault handler are specified between activities and variables.

```
<faultHandlers>
  <catch ... >
    <!-- Perform an activity -->
  </catch>
  <catch ... >
    <!-- Perform an activity -->
  </catch>
  ...
  <catchAll>
    <!-- catchAll is optional -->
    <!-- Perform an activity -->
  </catchAll>
</faultHandlers>
```

- `<catch>` activities to handle **specific faults**
- `<cathAll>` handle **all other faults**

Catch Attributes

Attributes:

- **faultName** : Specifies the name of the fault to be handled.
- **faultVariable** : Specifies the variable type used for fault data.

Additional exclusive attributes:

- **faultMessageType** : Specifies the WSDL message type of the fault to be handled.
- **faultElement** : Specifies the XML element type of the fault to be handled.

Catch example flexibility

The most common permissive variation in the fault handler

```
<faultHandlers>

  <catch faultName="trv:TicketNotApproved" >
    <!-- First fault handler -->
    <!-- Perform an activity -->
  </catch>
  <catch faultName="trv:TicketNotApproved" faultVariable="TravelFault" >
    <!-- Second fault handler -->
    <!-- Perform an activity -->
  </catch>
  <catch faultVariable="TravelFault" >
    <!-- Third fault handler -->
    <!-- Perform an activity -->
  </catch>
  <catchAll>
    <!-- Perform an activity -->
  </catchAll>
</faultHandlers>
```

NOTE: fault handlers are very similar to **try/catch** clauses in modern programming languages

Synchronous example

Usage of the <reply> to signal the fault to the client

```
<faultHandlers>
  <catch faultName="trv:TicketNotApproved" faultVariable="TravelFault">
  <reply partnerLink="client"
    portType="trv:TravelApprovalPT"
    operation="TravelApproval"
    variable="TravelFault"
    faultName="fault" />
  </catch>
  <catchAll>
    <sequence>
    <assign>
      <copy>
        <from>string('Other fault')</from>
        <to variable="TravelFault" part="error" />
      </copy>
    </assign>
    <reply partnerLink="client"
      portType="trv:TravelApprovalPT"
      operation="TravelApproval"
      variable="TravelFault"
      faultName="fault" />
    </sequence>
  </catchAll>
</faultHandlers>
```

Synchronous example

In the process instead of **reply** to the client we modify the process simply throwing a fault.

```
<!-- Check if the ticket is approved -->
<if>
  <condition>
    $TravelResponse.confirmationData/aln:Approved='true'
  </condition>
  <!-- Send a response to the client -->
  <reply partnerLink="client"
    portType="trv:TravelApprovalPT"
    operation="TravelApproval"
    variable="TravelResponse"/>
 <else>
  <sequence>
   <!-- Create the TravelFault variable with fault description -->
   <assign>
    <copy>
      <from>string('Ticket not approved')</from>
      <to variable="TravelFault" part="error" />
    </copy>
   </assign>
   <!-- Throw fault -->
    <throw faultName="trv:TicketNotApproved"
       faultVariable="TravelFault" />
   </sequence>
  </else>
</if>
```

Asynchronous Example

We need to define an additional **callback** for the fault.

```
<message name="TravelFaultMessage">
  <part name="error" type="xs:string" />
</message>
<portType name="ClientCallbackPT">
  <operation name="ClientCallback">
    <input message="aln:TravelResponseMessage" />
  </operation>
  <operation name="ClientCallbackFault">
    <input message="tns:TravelFaultMessage" />
  </operation>
</portType>
```

Asynchronous Example

In the <faultHandlers> we send back the fault using the <invoke> instead of the <reply>

```
<faultHandlers>
  <catch faultName="trv:TicketNotApproved"
         faultVariable="TravelFault">
    <!-- Make a callback to the client -->
    <invoke partnerLink="client"
       portType="trv:ClientCallbackPT"
       operation="ClientCallbackFault"
       inputVariable="TravelFault" />
  </catch>
  <catchAll>
    <sequence>
     <!-- Create the TravelFault variable -->
      <assign>
       <copy>
         <from>string('Other fault')</from>
         <to variable="TravelFault" part="error" />
       </copy>
      </assign>
      <invoke partnerLink="client"
        portType="trv:ClientCallbackPT"
        operation="ClientCallbackFault"
        inputVariable="TravelFault" />
    </sequence>
  </catchAll>
</faultHandlers>
```

Propagation of Faults

BPEL gives the possibility to propagate a fault to a higher-level fault handler.

```
<catchAll>
  <sequence>
    <compensate />
      <rethrow />
  </sequence>
</catchAll>
```

- The <rethrow> activity to **rethrow the fault caught by the fault handler**
- Rethrow can be used only within <catch> and <catchAll>

Inline Faults handling

- A more efficient way is to handle faults **directly in the activities**.
- The <invoke> activity provides a inline fault handlers without rely on a general fault handlers.

```
<invoke ... >
  <catch faultName="fault-name" >
    <!-- Perform an activity -->
  </catch>

  <catch faultName="fault-name"
        faultVariable="fault-variable"
      <!-- Perform an activity -->
  </catch>
  ...
  <catch faultName="fault-name"
        faultVariable="fault-variable"
        faultMessageType="WSDL-message" <!-- Optional one or the other -->
        faultElement="XML-element" >
      <!-- Perform an activity -->
  </catch>
</invoke>
```

Sopes

Scopes

- **Divide** complex business process into **hierarchically organized parts**.
- Provide **behavioural contexts for activities**.
- Allow to define **different fault handlers for different activities**

How Scopes can be Defined

The scopes can be define in the following way:

```
<scope>
  <partnerLinks>
    <!-- Partner link definitions local to scope. -->
  </partnerLinks>
  <messageExchanges>
    <!-- Message exchanges local to scope. -->
  </messageExchanges>
  <variables>
    <!-- Variable definitions local to scope. -->
  </variables>
  <correlationSets>
    <!-- Correlation sets local to scope.-->
  </correlationSets>
  <faultHandlers>
    <!-- Fault handlers local to scope. -->
  </faultHandlers>
  <compensationHandler>
    <!-- Compensation handlers local to scope. -->
  </compensationHandler>
  <terminationHandler>
    <!-- Termination handler local to scope. -->
  </terminationHandler>
  <eventHandlers>
    <!-- Event handlers local to scope. -->
  </eventHandlers>
</scope>
```

Scopes in the Travel Example

The travel example can be divided in three scopes:

- Retrieve the employee travel status (**RetrieveEmployeeTravelStatus**).
- Check the flight availability with both airlines (**CheckFlightAvailability**).
- Call back to the client (**CallbackClient**).

The **variables are limited to the scope** in which are defined

Compensation

Compensation

Consider the travel example enlarged with the following services:

- Reserve flight tickets
- Pay the ticket
- Reserve a hotel room
- Pay the room

- Consider the eventuality that the **business travel is not confirmed**
- The reservation and payment activities would have to be **undone** - **compensated**.
- In BPEL we need to **explicitly compensate** the different activities.
- Compensation is **required** in **long running** and **asynchronous loosely coupled communications**.
- BPEL require that the activity specifies a **reserve activity**, which can be **invoked if it is necessary to undo the effect** of that activity.

Fault Handling vs Compensation

- Fault handling: a business process tries to **recover from an activity that could not finish normally** because an exceptional situation has occurred.
- Compensation: **reverse the effects of a previous activity** or a set of activities that have been carried out successfully as part of a business process that is being abandoned.

Compensation handler can be defined for:

- The **scope**
- **Inline** for the `<invoke>` activity

Compensation handler for the scope

```
<scope>
  <partnerLinks>
    <!-- Partner link definitions local to scope. -->
  </partnerLinks>
  <messageExchanges>
    <!-- Message exchanges local to scope -->
  </messageExchanges>
  <variables>
    <!-- Variable definitions local to scope. -->
  </variables>
  <correlationSets>
    <!-- Correlation sets local to scope-->
  </correlationSets>
  <faultHandlers>
    <!-- Fault handlers local to scope. -->
  </faultHandlers>
  <compensationHandler>
    <!-- Compensation activity
       (or several activities within a <sequence>, <flow>, or other structured activity) -->
  </compensationHandler>
  <terminationHandler>
    <!-- Termination handler local to scope -->
  </terminationHandler>
  <eventHandlers>
    <!-- Event handlers local to scope-->
  </eventHandlers>
  activity
</scope>
```

Inline Compensation Handler

BPEL provides a shortcut for defining inline compensation handler rather than explicitly using an immediately enclosing scope.

```
<invoke ... >
  <compensationHandler>
    <!-- Compensation activity
         (or several activities within a <sequence>, <flow>,
         or other structured activity) -->
  </compensationHandler>
</invoke>
```

Events

Managing Events

Business process may have to react on certain events:

- Wait for an **incoming message** `<receive>` activity
- Wait for a **callback message**
- Wait for the **callback within a certain period of time**

In most of the case the system should **react on two types of events**:

- **Message events**: These are triggered by incoming messages through operation invocation on port types.
- **Alarm events**: These are time related and are triggered either after a certain duration or at a specific time.

Pick Activity

The <pick> activity **awaits the occurrence of one set of events**.

Event can be handled using:

- <onMessage> (1 .. n)
- <onAlarm> (0 .. n)

Syntax of pick activity:

```
<pick>
  <onMessage ...>
    <!-- Perform an activity -->
  </onMessage>
  <onMessage ...>
    <!-- Perform an activity -->
  </onMessage>
  ...
  <onAlarm ...>
    <!-- Perform an activity -->
  </onAlarm>
  ...
</pick>
```

Message Events

On message events we have to specify the following **attributes**:

- **PartnerLink** : Specifies which partner link will be used for the invoke
- **PortType** : Specifies the used port type
- **Operation** : Specifies the name of the operation to wait for being invoked
- **Receive or reply** variable : Specifies the name of the variable used to store the incoming message

```
<pick>
  <onMessage partnerLink="name"
     portType="name"
     operation="name"
     variable="name">
   <!-- Perform an activity or a set of activities enclosed by
        <sequence>, <flow>, etc. or throw a fault -->
</onMessage>
...
</pick>
```

Alarm Events

The <onAlarm> element is similar to the <wait> element indeed **we use the same literal**.

On alarm events we can specify the following:

- A **duration expression** using a <for> duration expression
- A **deadline expression** using an <until> deadline expression

Code example with hard-coded times/dates:

```
<pick>
  <onAlarm>
    <for>'PT15M'</for>
      <!-- Perform an activity or a set of activities enclosed by
           <sequence>, <flow>, etc. or throw a fault -->
  </onAlarm>
</pick>
<pick>
...
  <onAlarm>
    <until>'2004-03-18T21:00:00+01:00'</until>
      <!-- Perform an activity or a set of activities enclosed by
           <sequence>, <flow>, etc. or throw a fault -->
  </onAlarm>
</pick>
```

Travel Example using the Pick Activity

We substitute the <receive> activity with the <pick>.

```
<pick>
   <onMessage partnerLink="AmericanAirlines"
              portType="aln:FlightCallbackPT"
              operation="FlightTicketCallback"
              variable="FlightResponseAA">
         <empty/>
   </onMessage>
   <onMessage partnerLink="AmericanAirlines"
              portType="aln:FlightCallbackPT"
              operation="FlightNotAvaliable"
              variable="FlightFaultAA">
         <throw faultName="trv:FlightNotAvaliable"
                faultVariable="FlightFaultAA"/>
   </onMessage>
   <onMessage partnerLink="AmericanAirlines"
              portType="aln:FlightCallbackPT"
              operation="TicketNotAvaliable"
              variable="FlightFaultAA">
         <throw faultName="trv:TicketNotAvaliable"
                faultVariable="FlightFaultAA"/>
   </onMessage>
   <onAlarm>
      <for>'PT30M'</for>
      <throw faultName="trv:CallbackTimeout" />
   </onAlarm>
</pick>
```

Event Handler

Event handlers

- With `<pick>` the business process **should wait for events**
- With `Event handler` the system **react on events** that occur while BP executes.

The event handler permit the system to **continue the execution** and still **listen the events** and **handle them** whenever they occur.

- Event Handler is **invoked concurrently** with the business process

Typical usage of event handler usage could be the **cancellation message** from the client referring the travel example

Event handlers

Event handlers can be specified for the whole process as well for each scope.

```
<process ...>
   <partnerLinks>
      ...
   </partnerLinks>
   <variables>
      ...
   </variables>
   <faultHandlers>
      ...
   </faultHandlers>
   <compensationHandler>
      ...
   </compensationHandler>
   <eventHandlers>
      <onEvent ...>
         <!-- Perform activities -->
      </onEvent>
      ...
      <onAlarm ...>
         <!-- Perform activities -->
      </onAlarm>
      ...
   </eventHandlers>
  activity
</process>
```

Event Handlers

The syntax of Event Handler is similar to the `<pick>` activity.
There are two typology of events:

- `<onEvent>` for message event (`1 .. n`)
- `<onAlarm>` for deadline (`1 .. n`)

onEvent

The **event handler will wait for a message to arrive**.

The event syntax is :

```
<eventHandlers>
  <onEvent partnerLink="name"
      portType="name" <!-- Optional -->
      operation="name"
      messageType="name" <!-- Optional -->
      element="name" <!-- Optional -->
      variable="name" <!-- Optional -->
      messageExchange="name"> <!-- Optional -->
  <correlations>
    <correlation set="name" initiate="yes|join|no"? />
  </correlations>
  <fromParts> <!-- Optional -->
    <fromPart part="name" toVariable="name" />
  </fromParts>
  <scope>
    <!-- Perform activities -->
   </scope>
  </onEvent>
...
</eventHandlers>
```

Event handlers onEvents attributes

- **Partnerlink** partnerlink of the service that can send the message.
- **Operation**: Operation of the partner that cause the event
- **PortType**: contain the operation that will be invoked
- **Variable**: contain the message exchanged by the partners. (It is possible to specify the MessageType or the element)

Event Handler on Travel Example

```
<process name="Travel" ... >
   ...
   <eventHandlers>
      <onEvent partnerLink="client"
               portType="trv:TravelApprovalPT"
               operation="CancelTravelApproval"
               messageType="trv:TravelRequestMessage"
               variable="TravelRequest" >
        <scope>
           <exit/>
        </scope>
     </onEvent>
   </eventHandlers>
 ...
</process>
```

onAlarm

The `<onAlarm>` element indicates a **time-driven event**

- We can specify a **time duration** after which the event will be signaled. (`<for>`)
- We can specify a **specific point in time (deadline)** when the alarm will be fired. (`<until>`)
- We can also specify a **repeating duration event**. An alarm will be fired repeatedly each time the duration period expires. (`<repeatEvery>`)

onAlarm syntax

The syntax of an <onAlarm> handler is shown as follows:

```
<eventHandlers>
   <onAlarm>
      <for>duration-expression</for> <!-- Optional -->
      <until>deadline-expression</until> <!-- Optional -->
      <repeatEvery>
         duration-expression
      </repeatEvery> <!-- Optional -->
      <scope>
         <!-- Perform activities -->
      </scope>
   </onAlarm>
...
</eventHandlers>
```

The system handle an error for 12 hours:

```
<process name="Travel" ... >
   ...
     <eventHandlers>
       <onAlarm>
          <for>'PT12H'</for>
          <scope>
             <exit/>
          </scope>
        </onAlarm>
      </eventHandlers>
...
</process>
```

Business process lifecycle

Business process lifecycle

The business process lifecycle:

- Start with the `<alert>`/`<pick>` activity
- Typically invokes several operation on partner web services.
- Wait for partners callback
- Terminate after all activity are performed

In BPEL we **do not create instances explicitly** like in programming languages.

Business process lifecycle

Travel Business process lifecycle.

```
...
<sequence>
    <!-- Receive the initial request for business travel from client-->
    <receive partnerLink="client"
            portType="trv:TravelApprovalPT"
            operation="TravelApproval"
            variable="TravelRequest"
            createInstance="yes" />
...
<pick createInstance="yes">
   <onMessage partnerLink="client"
             portType="trv:TravelApprovalPT"
             operation="TravelApproval"
             variable="TravelRequest" >
         <!-- Perform activities -->
   </onMessage>
   <onMessage partnerLink="client"
             portType="trv:TravelCancellationPT"
             operation="TravelCancellation"
             variable="TravelCancel" >
         <!-- Perform activities -->
   </onMessage>
</pick>
```

Correlation and message properties

Correlation set

BPEL uses the notion of properties to assign global names to relevant data used for correlation messages.

Two roles can be defined:

- **Initiator**: is the partner that sends the first message in an operation invocation
- **Followers**: other partners that interact using the same message.

A correlation set is used to **associate messages with business process instances**.

```
<correlationSets>
  <correlationSet name="correlation-set-name"
     properties="list-of-properties"/>
  <correlationSet name="correlation-set-name"
     properties="list-of-properties"/>
</correlationSets>
```

```
<process ... >
   <partnerLinks>...</partnerLinks>
   <variables>...</variables>
   <correlationSets>
      <correlationSet name="TicketOrder"
          properties="aln:FlightNo"/>
   </correlationSets>
   ...
```

Using Correlation Set

Correlation can be used in the `<invoke>`, `<receive>`, `<reply>`, `<onMessage>`, `<pick>` and `<onEvent>`

It is necessary to define where the correlation applies

```
<correlations>
  <correlation set="name" initiate="yes|join|no"
     <!-- Optional -->
       pattern="request|response|request-response" />
</correlations>
```

Correlation Set in the Travel example

```
<sequence>
  <!-- Check the flight avaliablity -->
    <invoke partnerLink="AmericanAirlines"
            portType="aln:FlightAvailabilityPT"
            operation="FlightAvailability"
            inputVariable="FlightDetails" />
  <!-- Wait for the callback -->
   <receive partnerLink="AmericanAirlines"
            portType="aln:FlightCallbackPT"
            operation="FlightTicketCallback"
            variable="TravelResponse" >
  <!-- The callback includes flight no therefore initiate correlation set -->
  <correlations>
     <correlation set="TicketOrder"
                  initiate="yes" />
      </correlations>
</receive>
...
<!-- Synchronously confirm the ticket -->
<invoke partnerLink="AmericanAirlines"
        portType="aln:TicketConfirmationPT"
        operation="ConfirmTicket"
        inputVariable="FlightRespnseAA"
        outputVariable="Confirmation" >
<!-- Use the correlation set to confirm the ticket -->
<correlations>
   <correlation set="TicketOrder"
                pattern="request-response" />
</correlations>
```

Correlation Set in the Travel example

```
<!-- Make a callback to the client -->
<invoke partnerLink="client"
        portType="trv:ClientCallbackPT"
        operation="ClientCallback"
        inputVariable="TravelResponse" >
 <!-- Use the correlation set to callback the client -->
  <correlations>
        <correlation set="TicketOrder"
                    pattern="request" />
        </correlations>
</invoke>
</sequence>
</process>
```

Dynamic Partner Links

Dynamic Partner links

Usually:

- Partner links are **defined at design time**
- A **single endpoint is defined for each role**

With dynamic partner links:

- Partner link **endpoint can be referenced at runtime**
- BPEL can **decide which web service can used at runtime**

BPEL should comunicate with **web services that have the same WSDL interface** (American and Delta airline in the travel service)

Endpoint references

- BPEL uses **endpoint references defined by WS-Addressing**
- For each BPEL **instance** and for each **partner role** in a partner link a **unique endpoint** reference exists

We can copy:

- from a partner link to a partner link
- from a partner link to a variable
- from a variable to a partner link

```
<assign>
  <copy>
    <from partnerLink="name"
          endpointReference="myRole|partnerRole"/>
    <to partnerLink="name"/>
  </copy>
</assign>
```

```
<assign>
  <copy>
    <from partnerLink="name"
          endpointReference="myRole|partnerRole"/>
    <to variable="varName"/>
  </copy>
</assign>
```

Endpoint reference

To dynamically assign an endpoint reference to a partner link, we have to withdraw a service from the **service reference container** `<sref:service-ref>` and copy it to the partner link or copy the XML literal to the partner link.

The endpoint reference are contained in a reference container

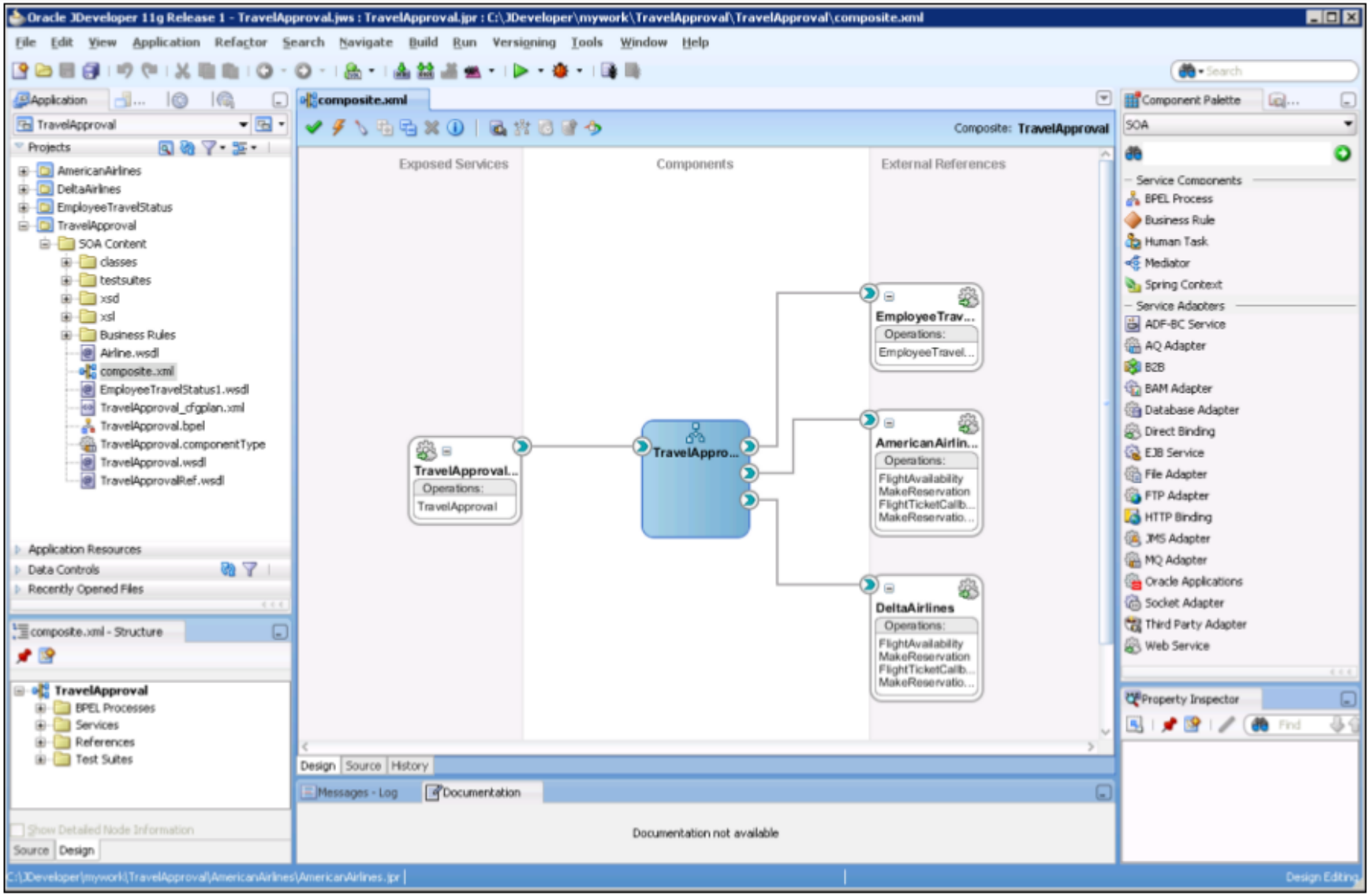
```
<EndpointReference xmlns="http://schemas.xmlsoap.org/ws/2004/08/
addressing">
<Address>ServiceURL</Address>
<ReferenceProperties>...</ReferenceProperties> <!--optional-->
<ReferenceParameters>...</ReferenceParameters> <!--optional-->
<PortType>PortTypeName</PortType> <!--optional-->
<ServiceName PortName="...">ServiceName</ServiceName> <!--optional-->
</EndpointReference>
```

Dynamic binding using literal

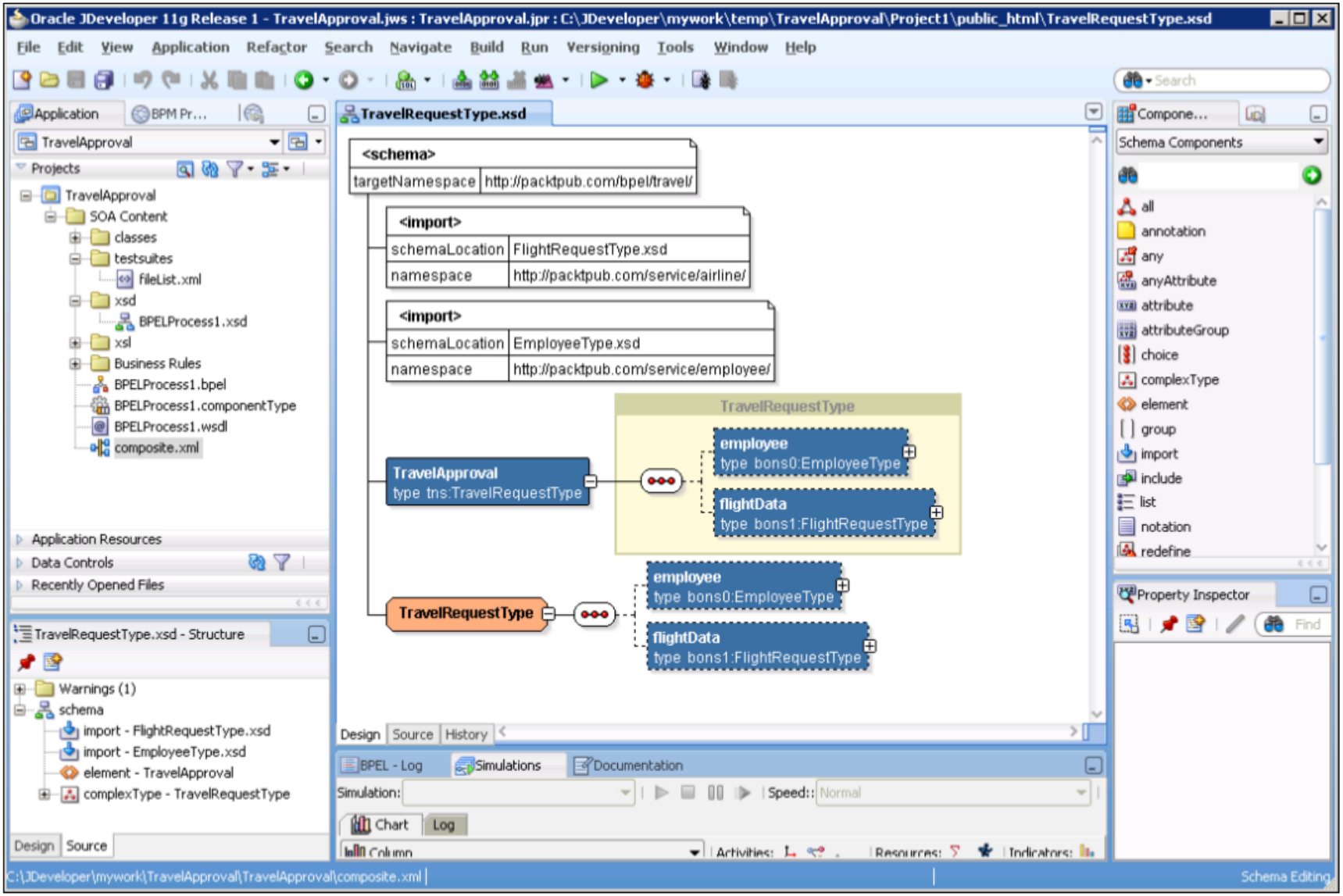
```
<assign>
  <copy>
    <from>
      <literal>
        <sref:service-ref
               xmlns:sref="http://docs.oasis-
               open.org/wsbpel/2.0/serviceref">
        <EndpointReference
               xmlns="http://schemas.xmlsoap.org/ws/2004/08/addressing">
          <Address>
             http://www.soa.si/default/AmericanAirline
          </Address>
        </EndpointReference>
        </sref:service-ref>
      </literal>
    </from>
    <to partnerLink="Airline"/>
  </copy>
</assign>
```

Building BPEL application Using JDeveloper

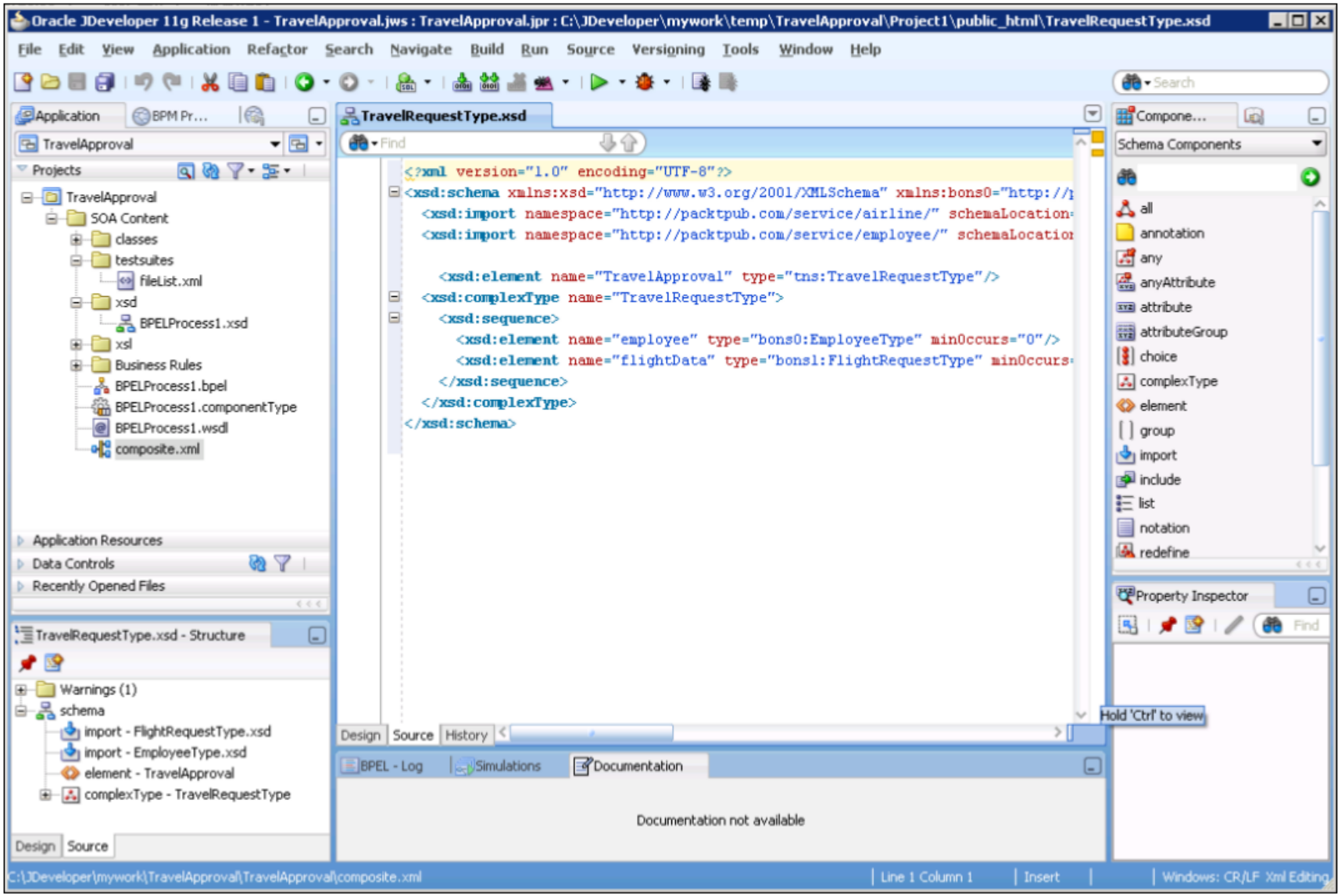
SOA Editor


Oracle JDeveloper 11g Release 1 - TravelApproval.jws : TravelApproval.jpr : C:\JDeveloper\mywork\TravelApproval\TravelApproval\composite.xml
File Edit View Application Refactor Search Navigate Build Run Versioning Tools Window Help
Application
TravelApproval
Projects
AmericanAirlines
DeltaAirlines
EmployeeTravelStatus
TravelApproval
SOA Content
classes
testsuites
xsd
xsl
Business Rules
Airline.wsdl
composite.xml
EmployeeTravelStatus1.wsdl
TravelApproval_cfgplan.xml
TravelApproval.bpel
TravelApproval.componentType
TravelApproval.wsdl
TravelApprovalRef.wsdl
Application Resources
Data Controls
Recently Opened Files
composite.xml - Structure
TravelApproval
BPEL Processes
Services
References
Test Suites
Show Detailed Node Information
Source Design
composite.xml
Composite: TravelApproval
Exposed Services
Components
External References
TravelApproval...
Operations:
TravelApproval
TravelAppro...
EmployeeTrav...
Operations:
EmployeeTravel...
AmericanAirlin...
Operations:
FlightAvailability
MakeReservation
FlightTicketCalib...
MakeReservatio...
DeltaAirlines
Operations:
FlightAvailability
MakeReservation
FlightTicketCalib...
MakeReservatio...
Design Source History
Messages - Log
Documentation
Documentation not available
Component Palette
SOA
Service Components
BPEL Process
Business Rule
Human Task
Mediator
Spring Context
Service Adapters
ADF-BC Service
AQ Adapter
B2B
BAM Adapter
Database Adapter
Direct Binding
EJB Service
File Adapter
FTP Adapter
HTTP Binding
JMS Adapter
MQ Adapter
Oracle Applications
Socket Adapter
Third Party Adapter
Web Service
Property Inspector
Find
C:\JDeveloper\mywork\TravelApproval\AmericanAirlines\AmericanAirlines.jpr
Design Editing

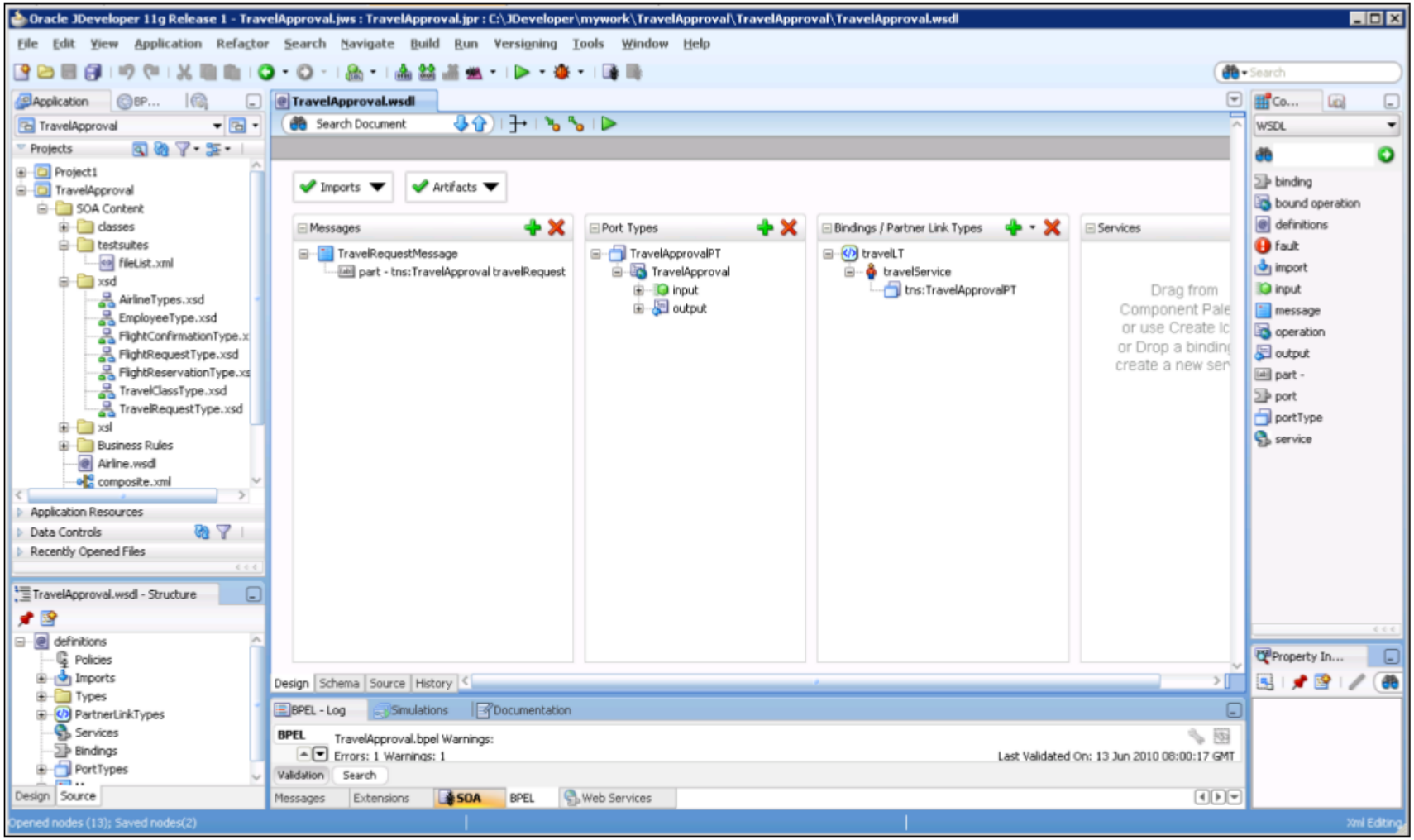
Defining XML schemas



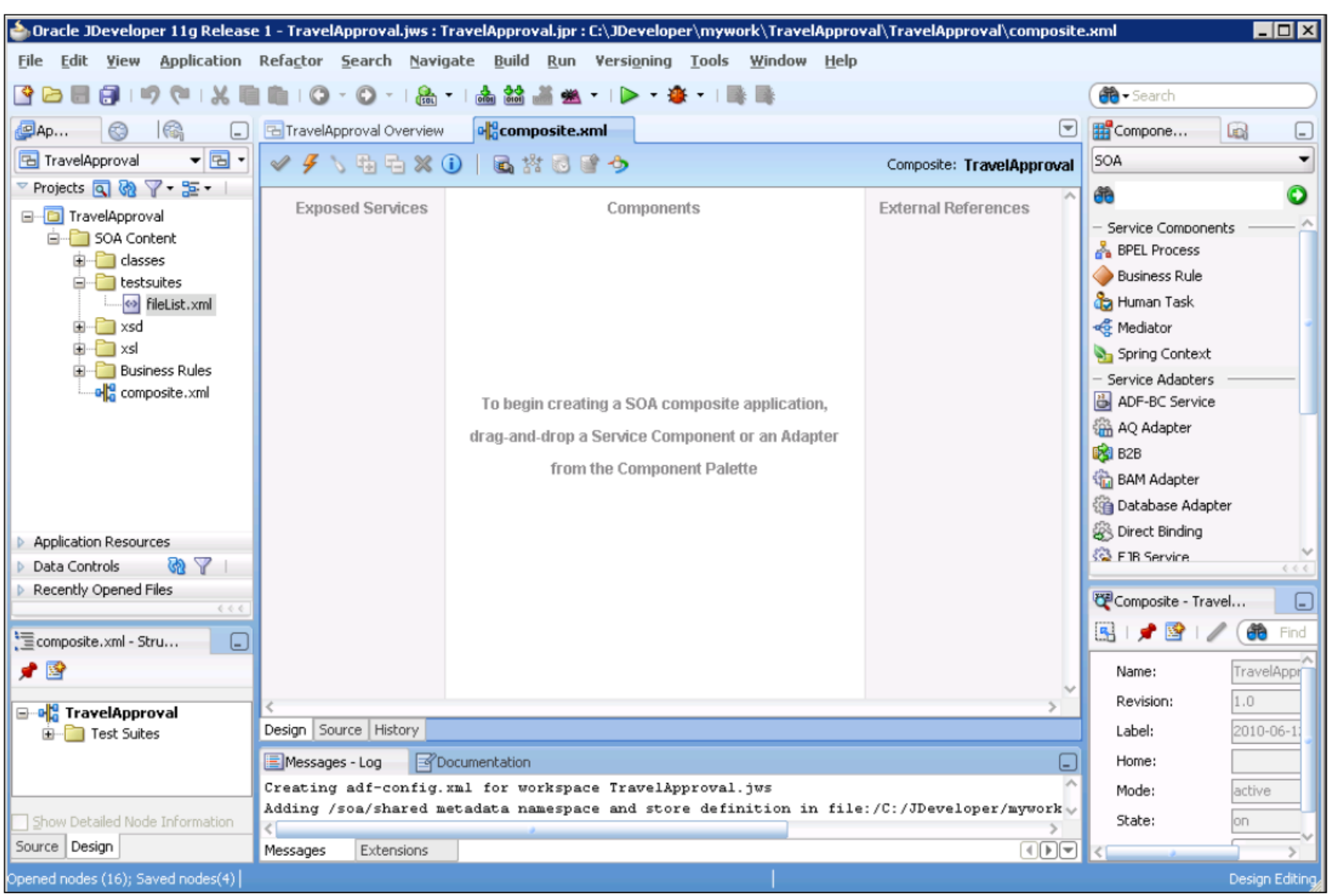
Defining XML schemas source



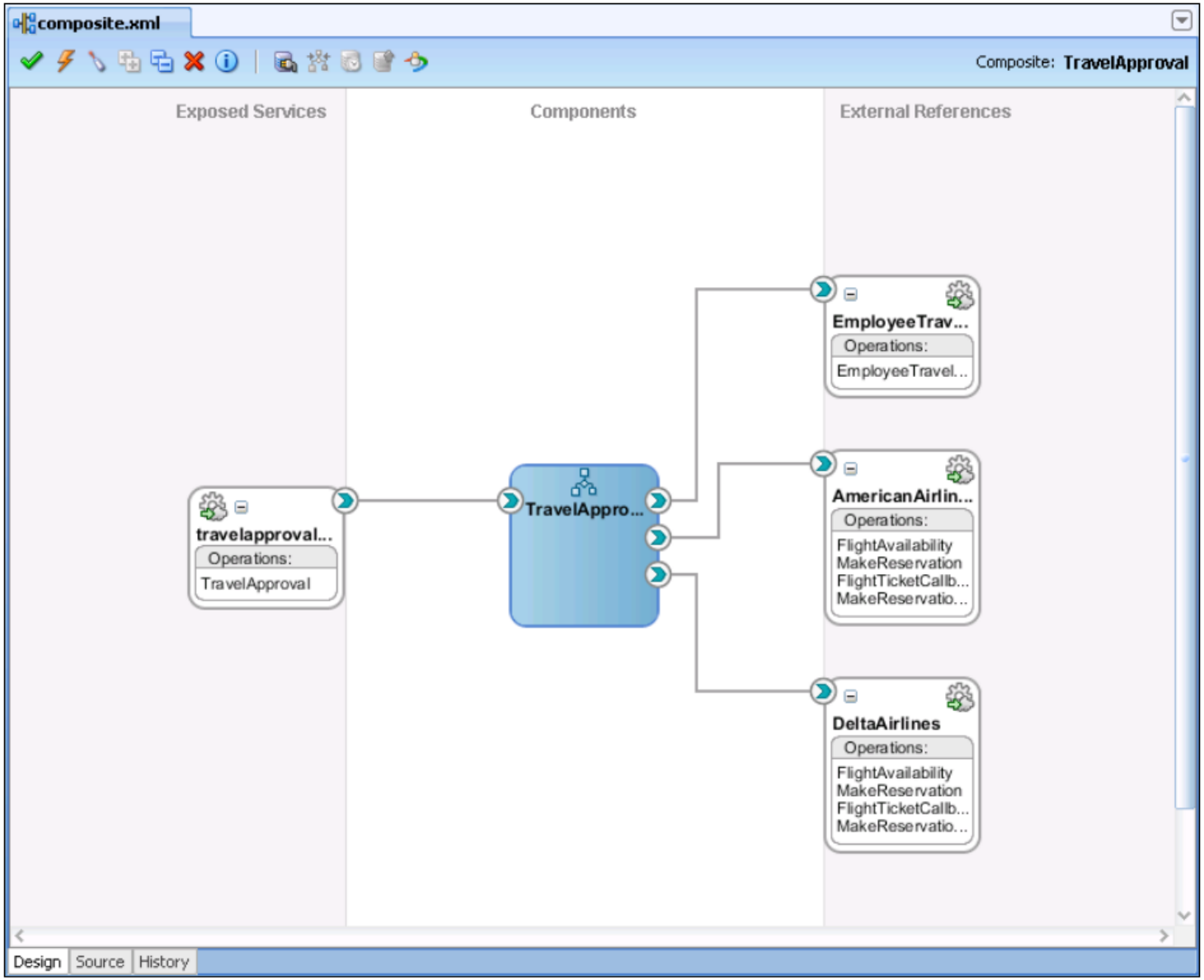
Defining WSDL



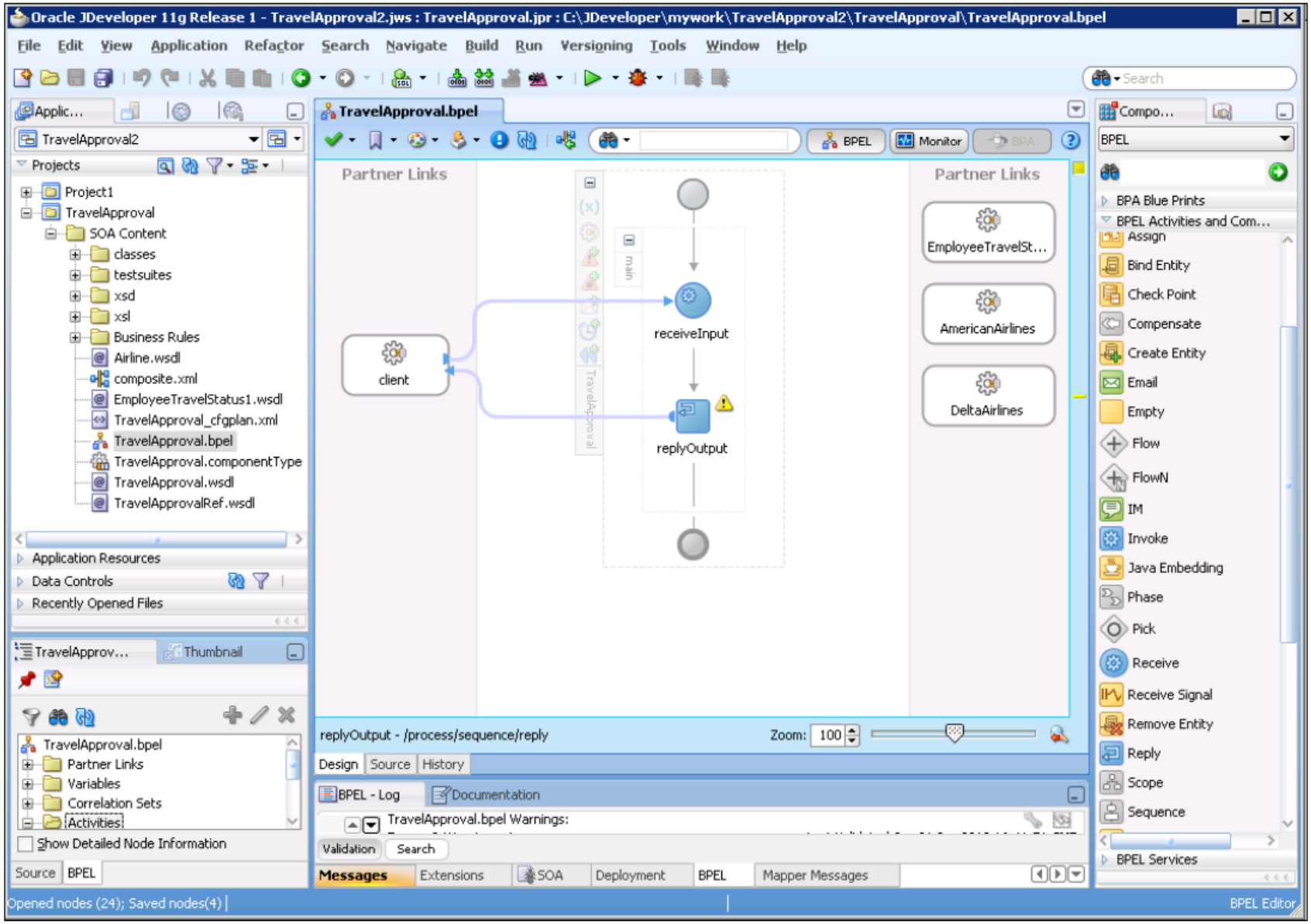
SOA Composite Application



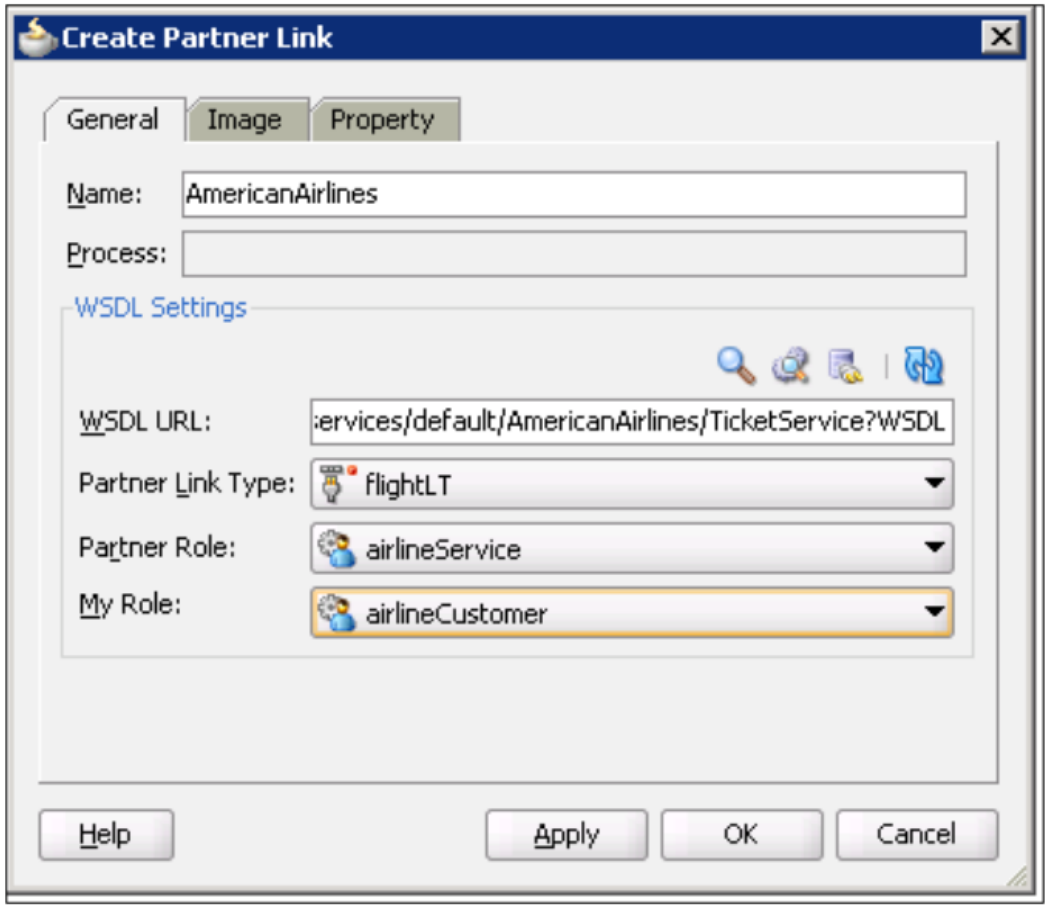
SOA Composite Application



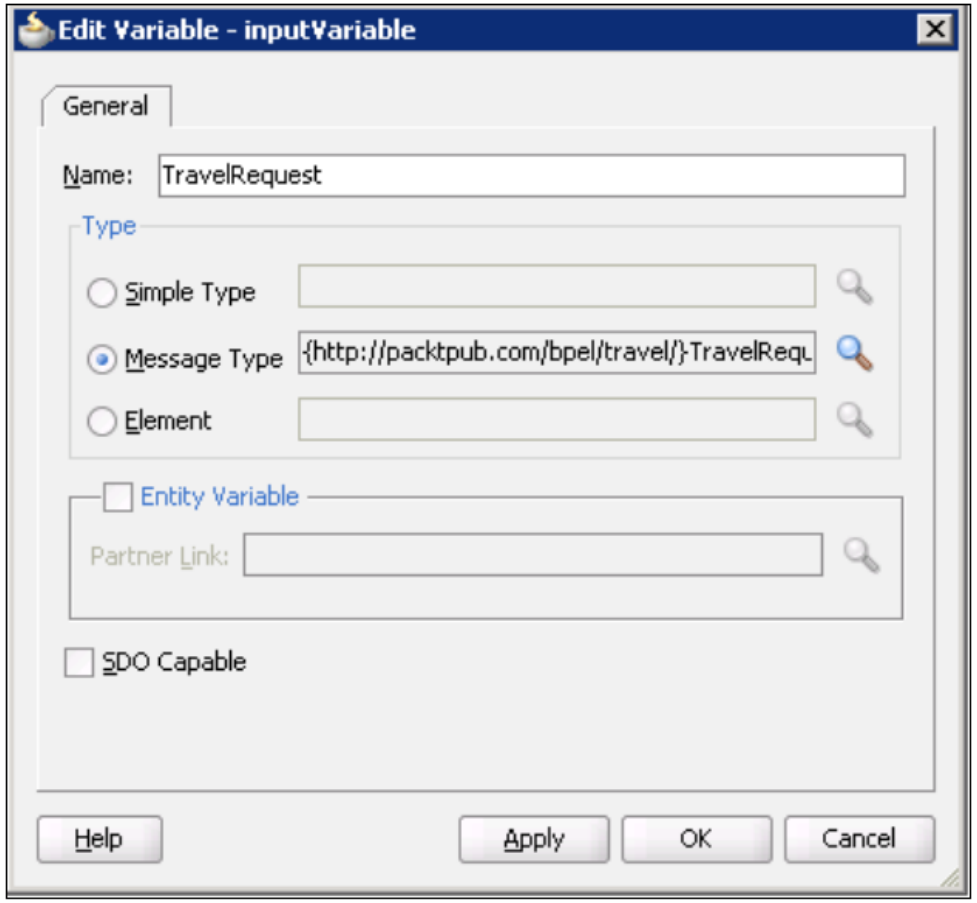
BPEL Operation Design



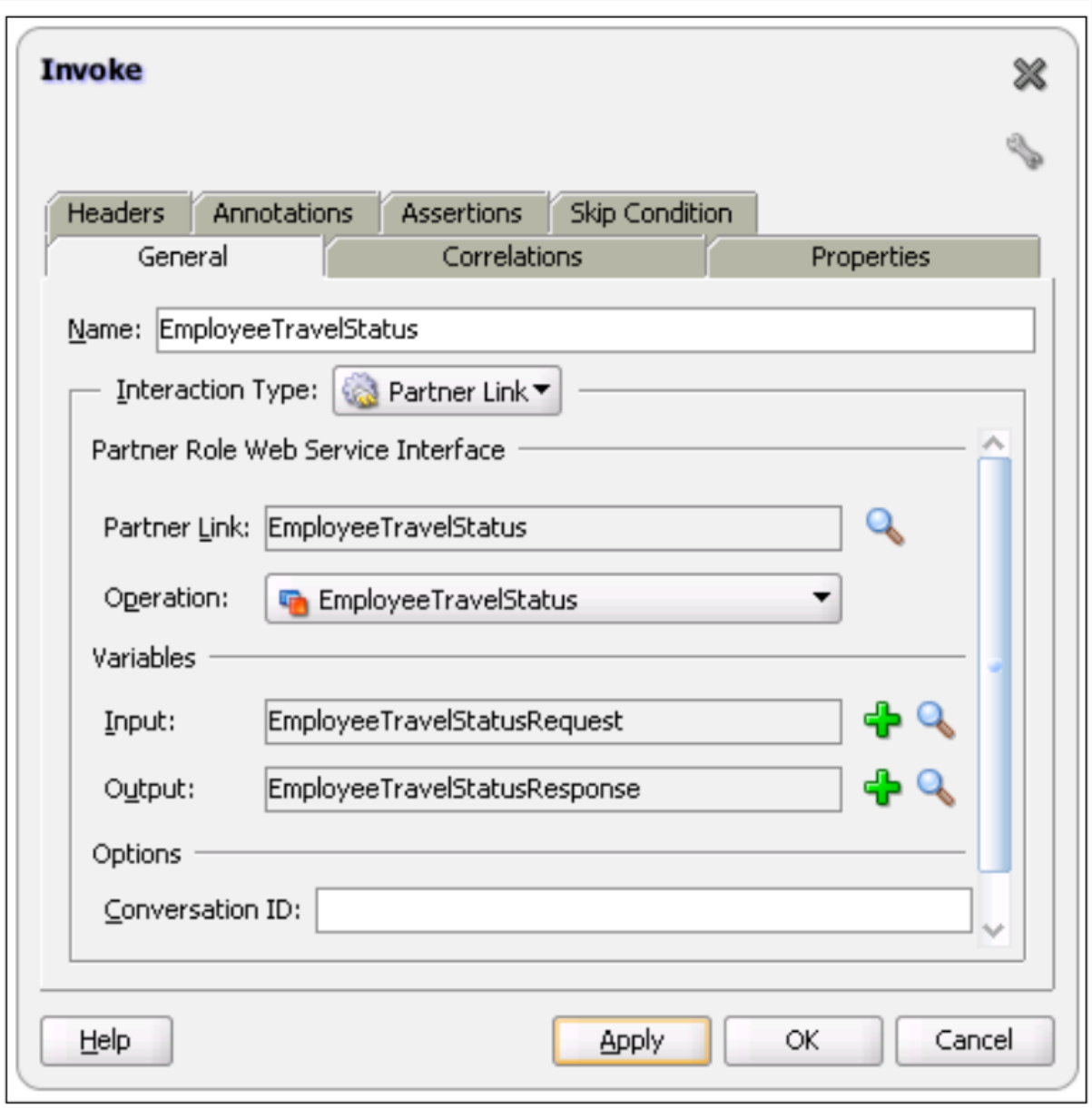
Partner Link Definition



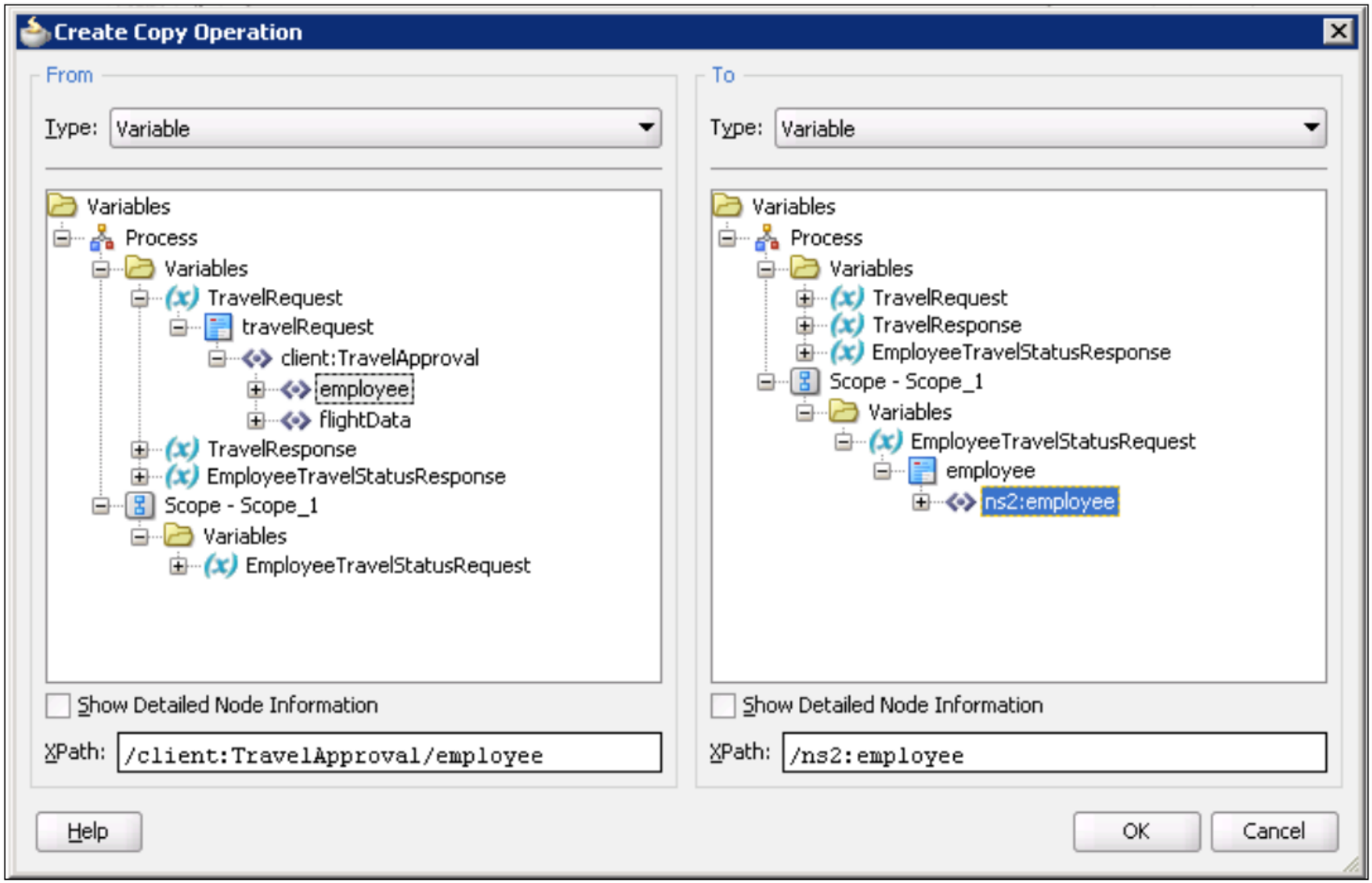
Variables Definition



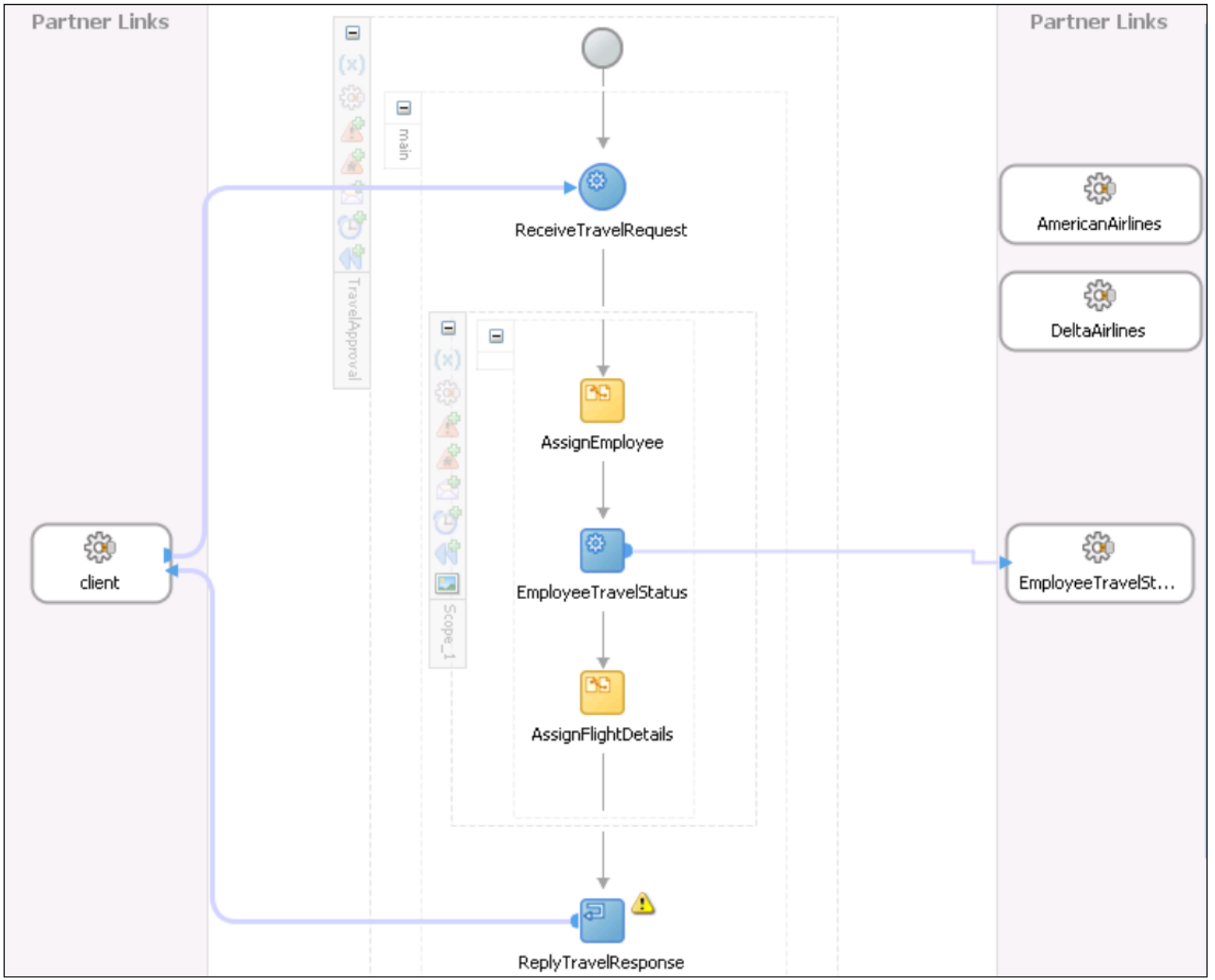
Invoke Operation



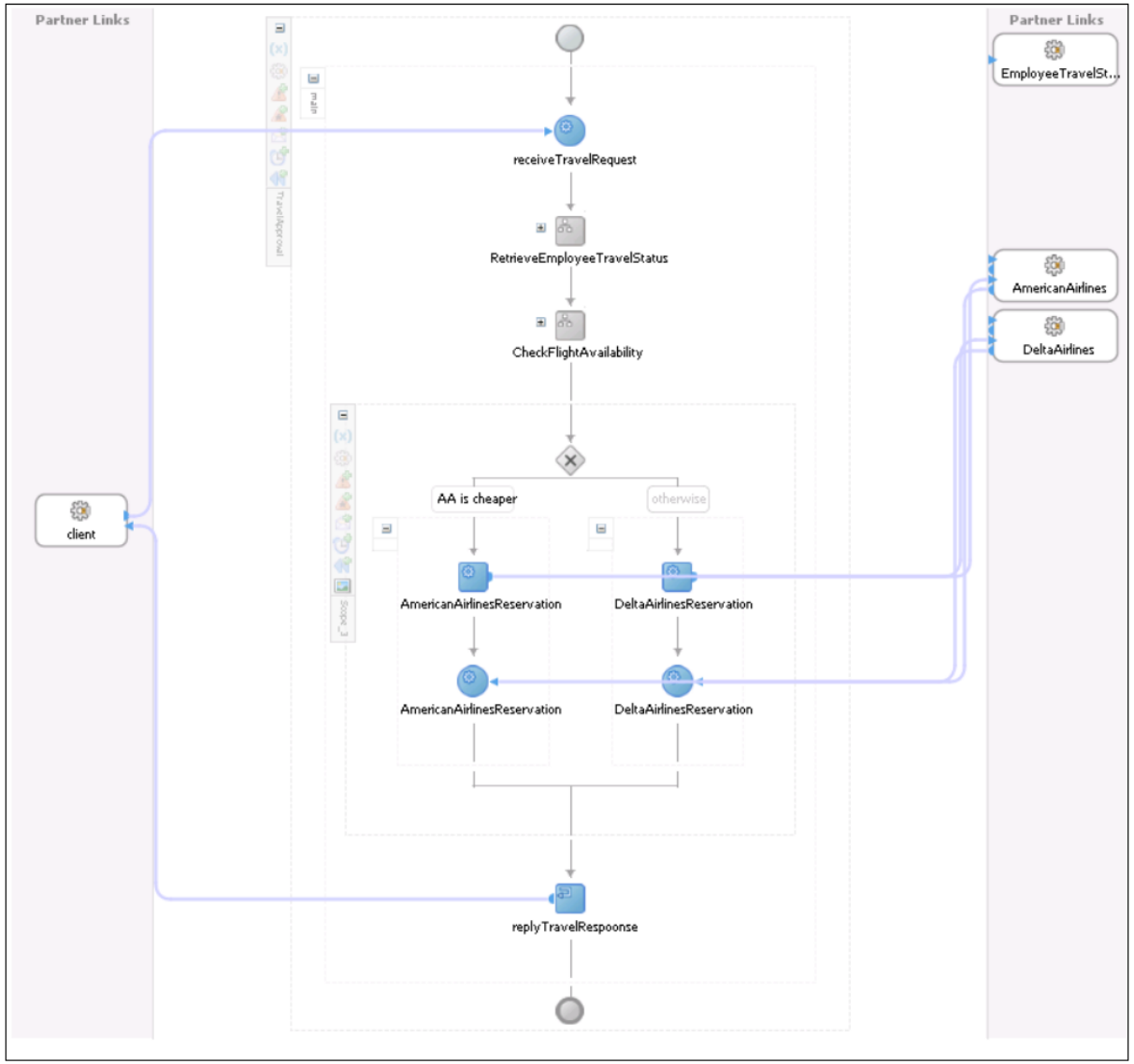
Assign Operation



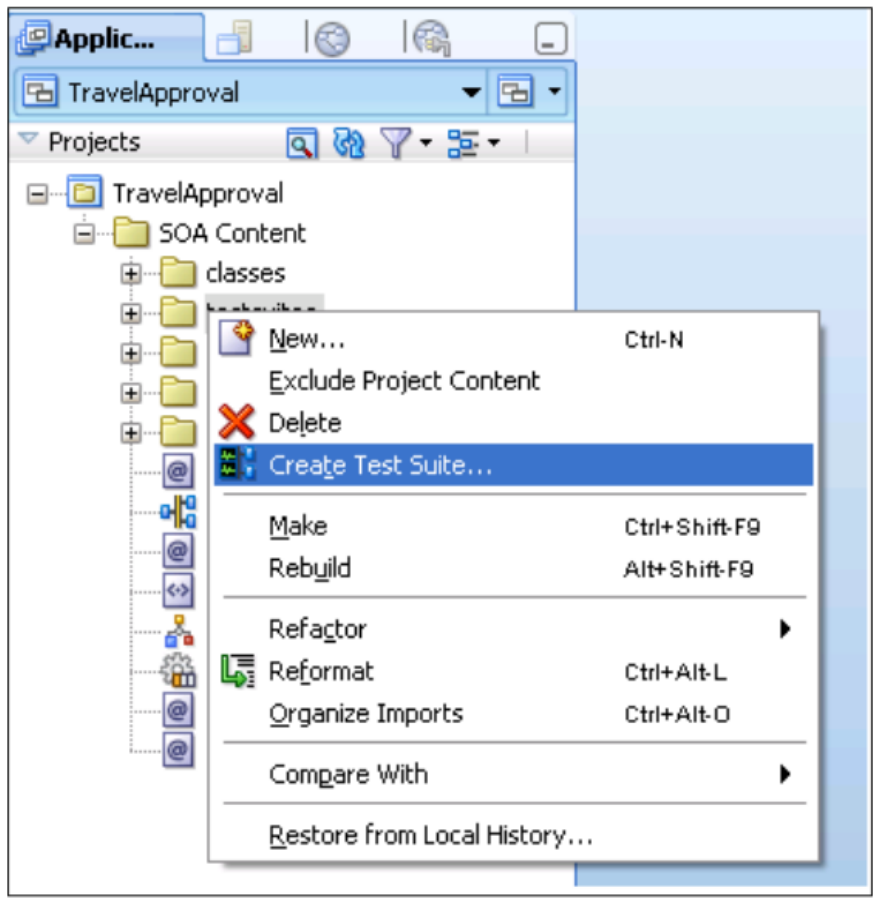
Definition of variables in the Operations



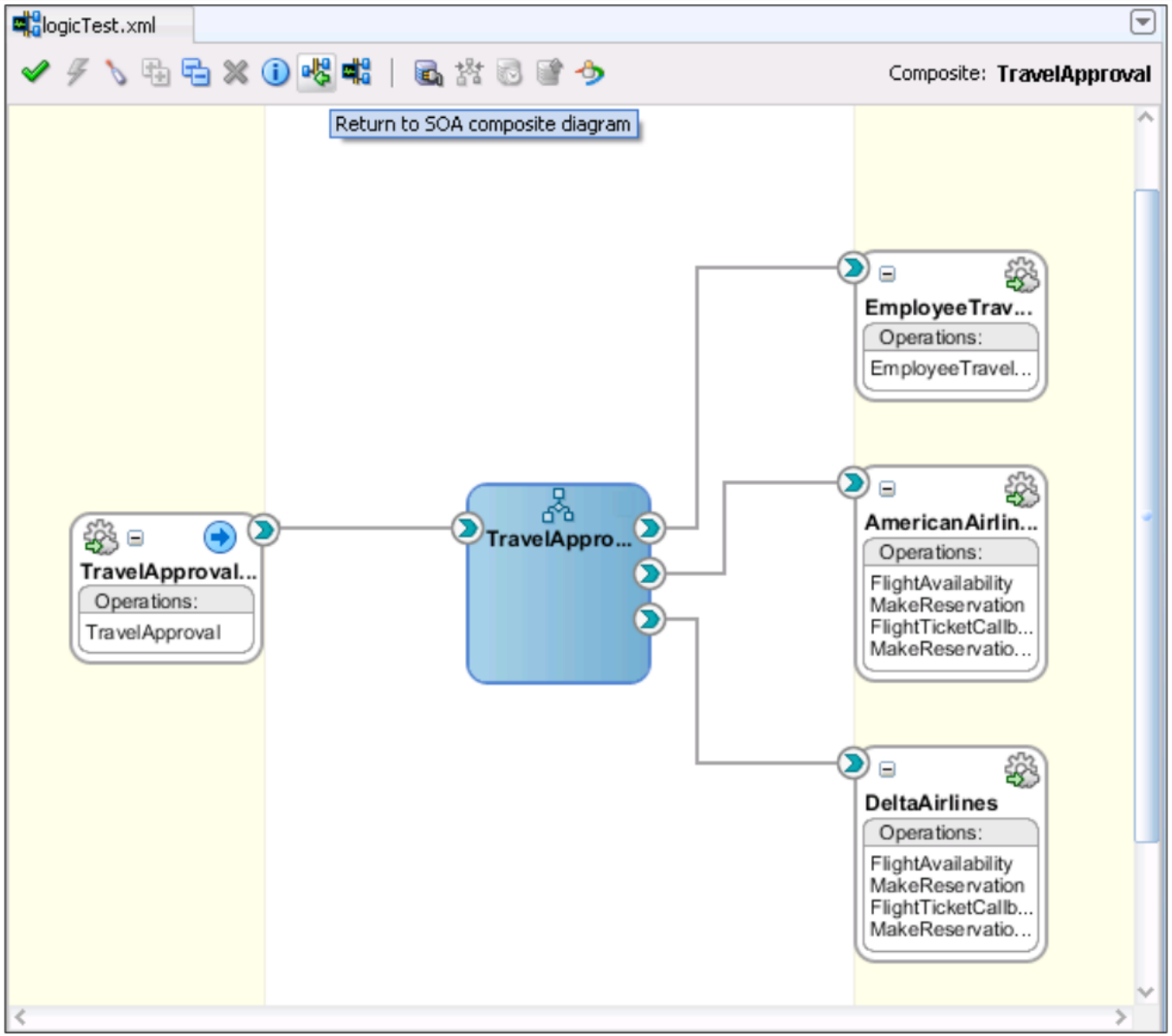
BPEL Complete Process



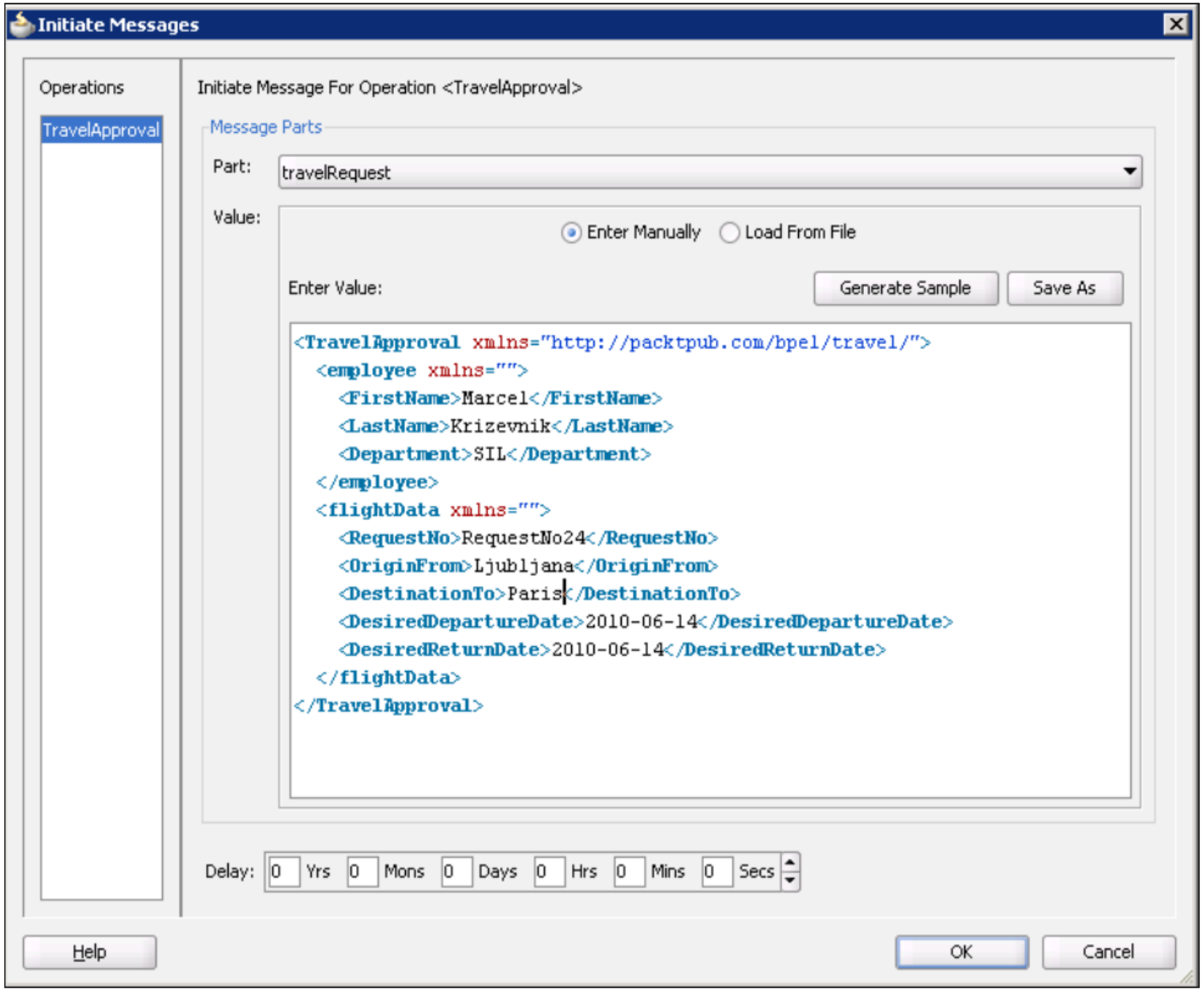
Test Suite Creation



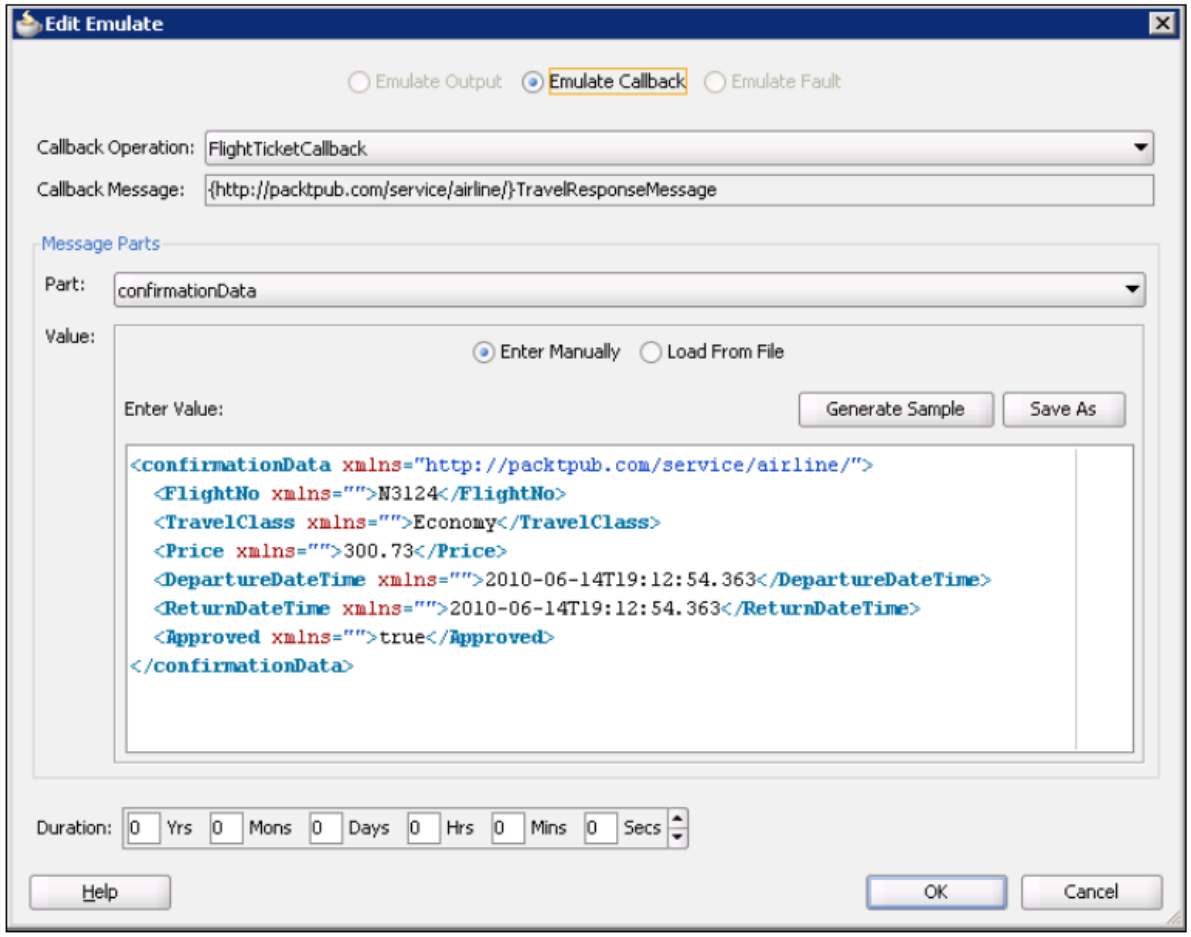
Composite Diagram



TravelRequest Operation

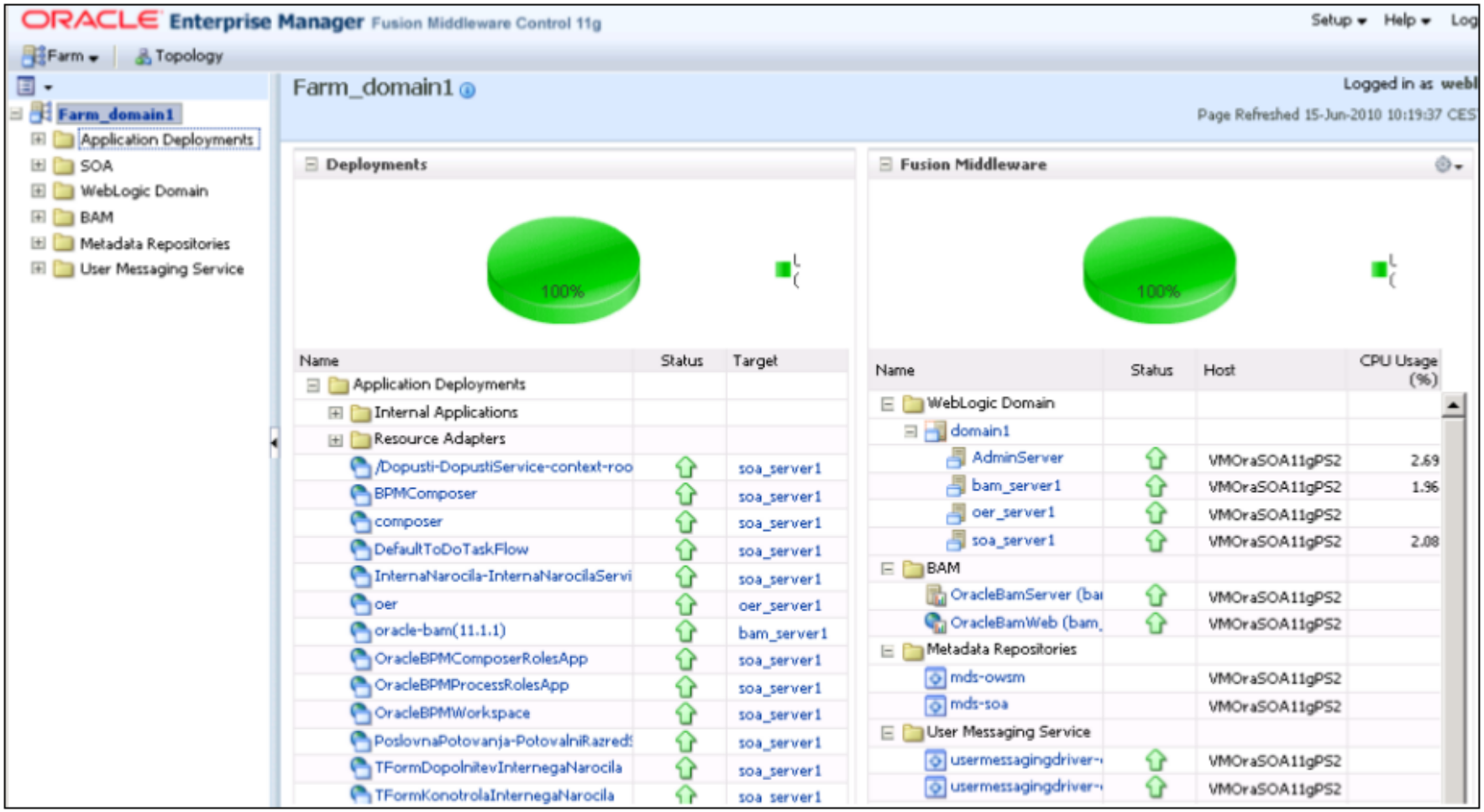


TicketCallback Operation

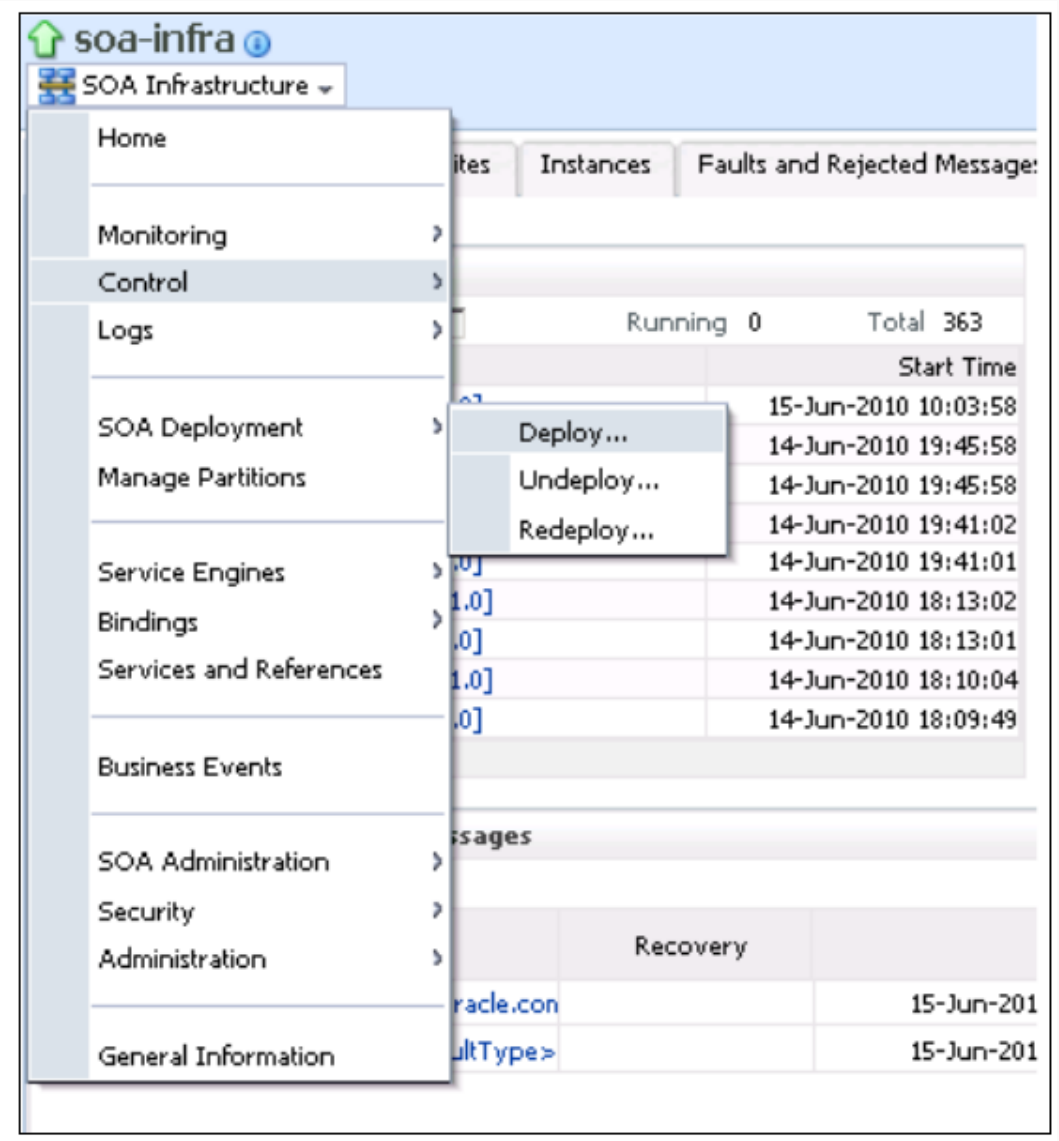


Deploy

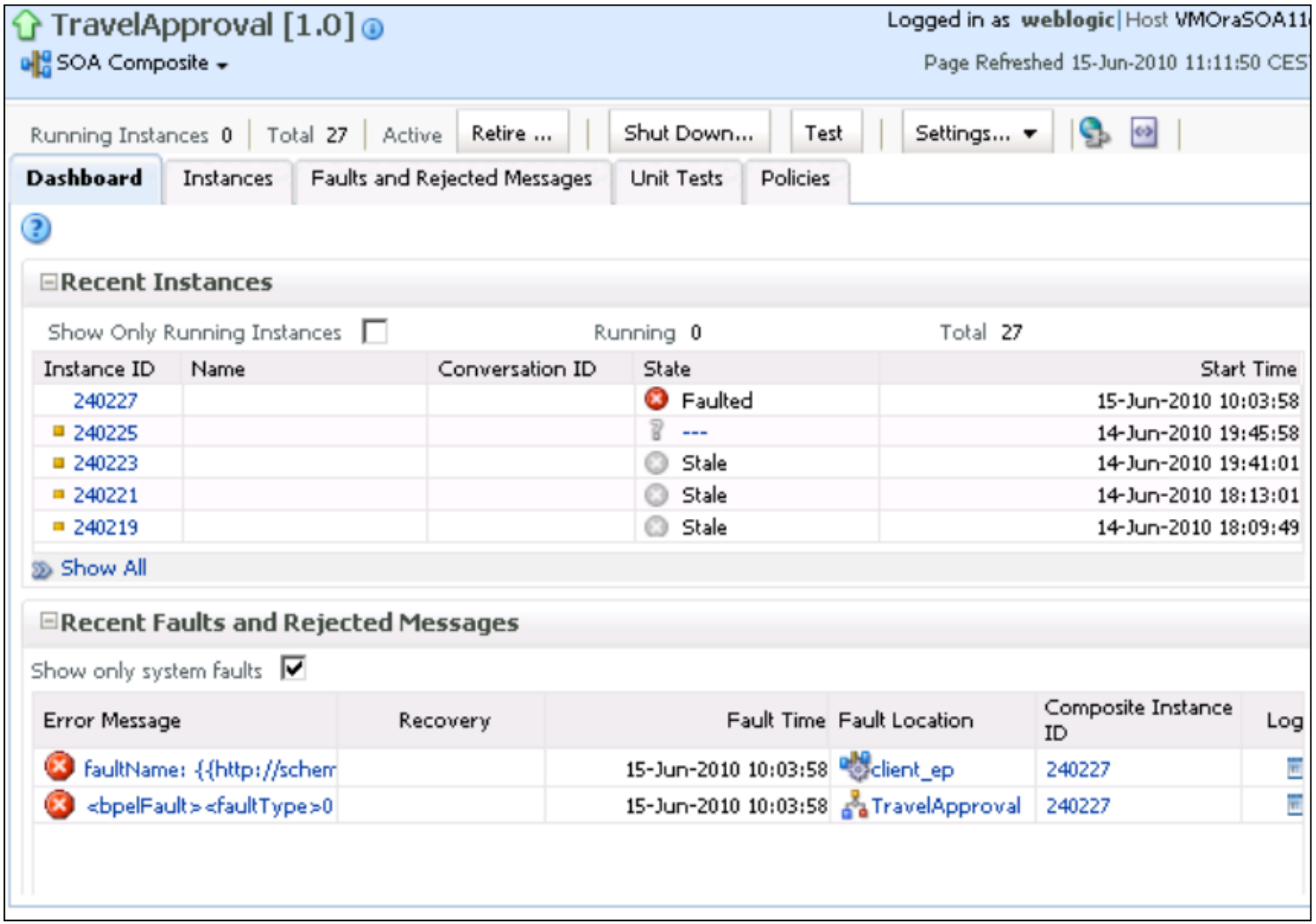
Enterprise Manager Console



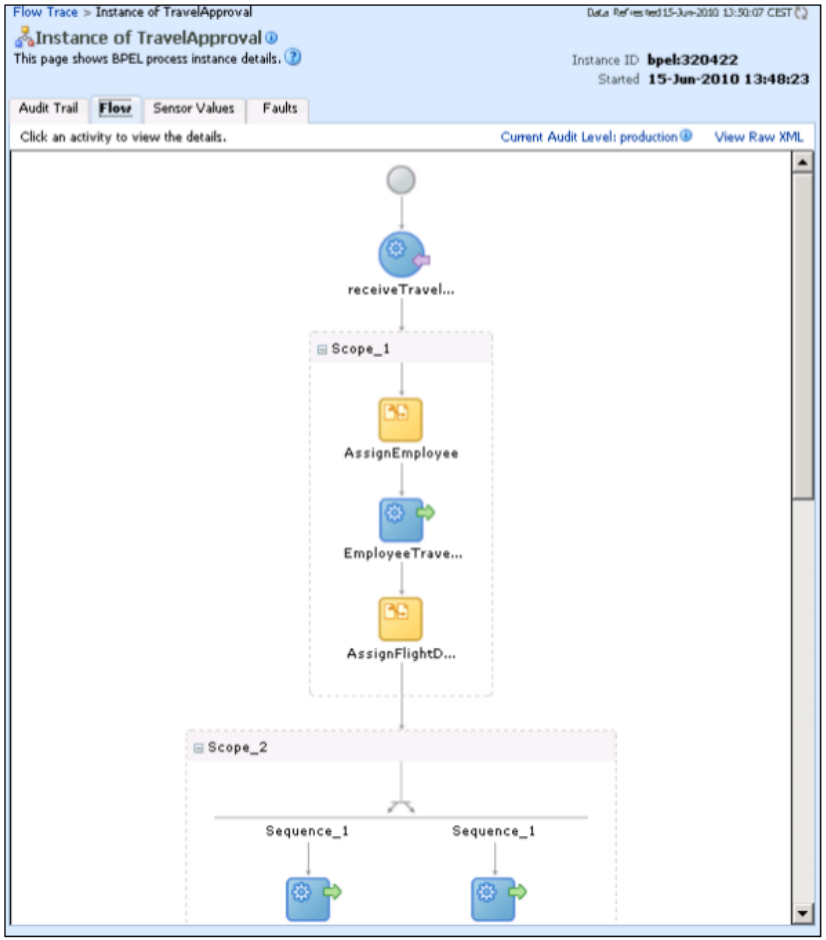
Deploy and Undeploy Services

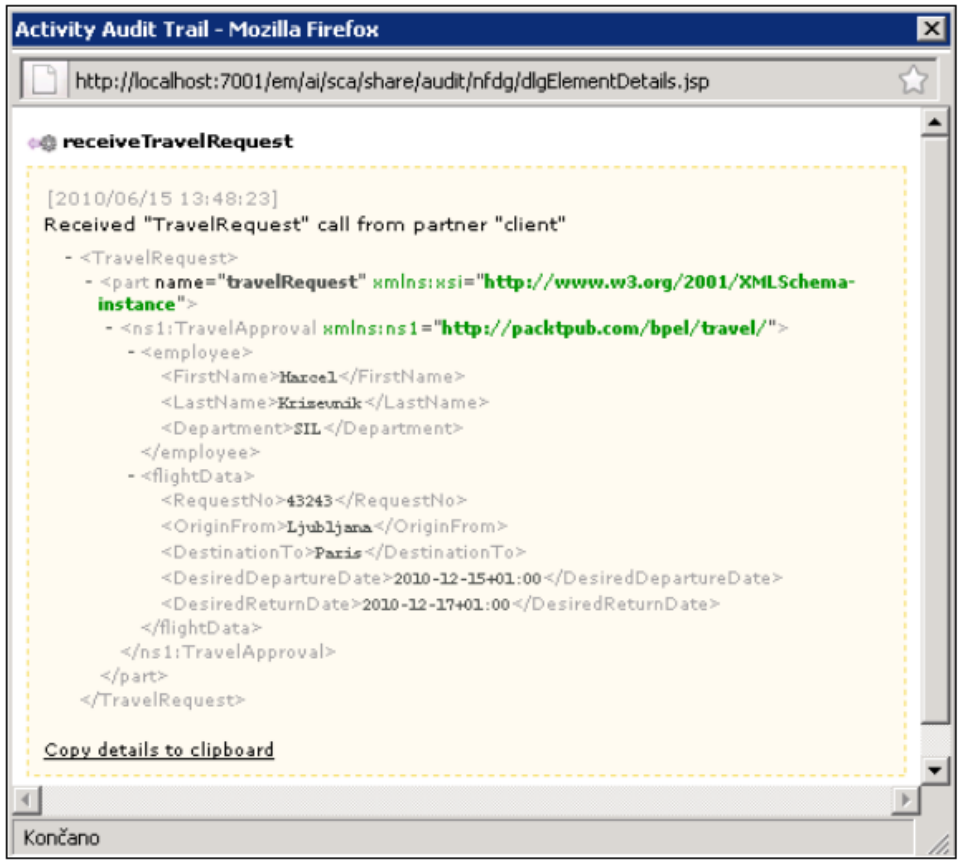


Test Instances

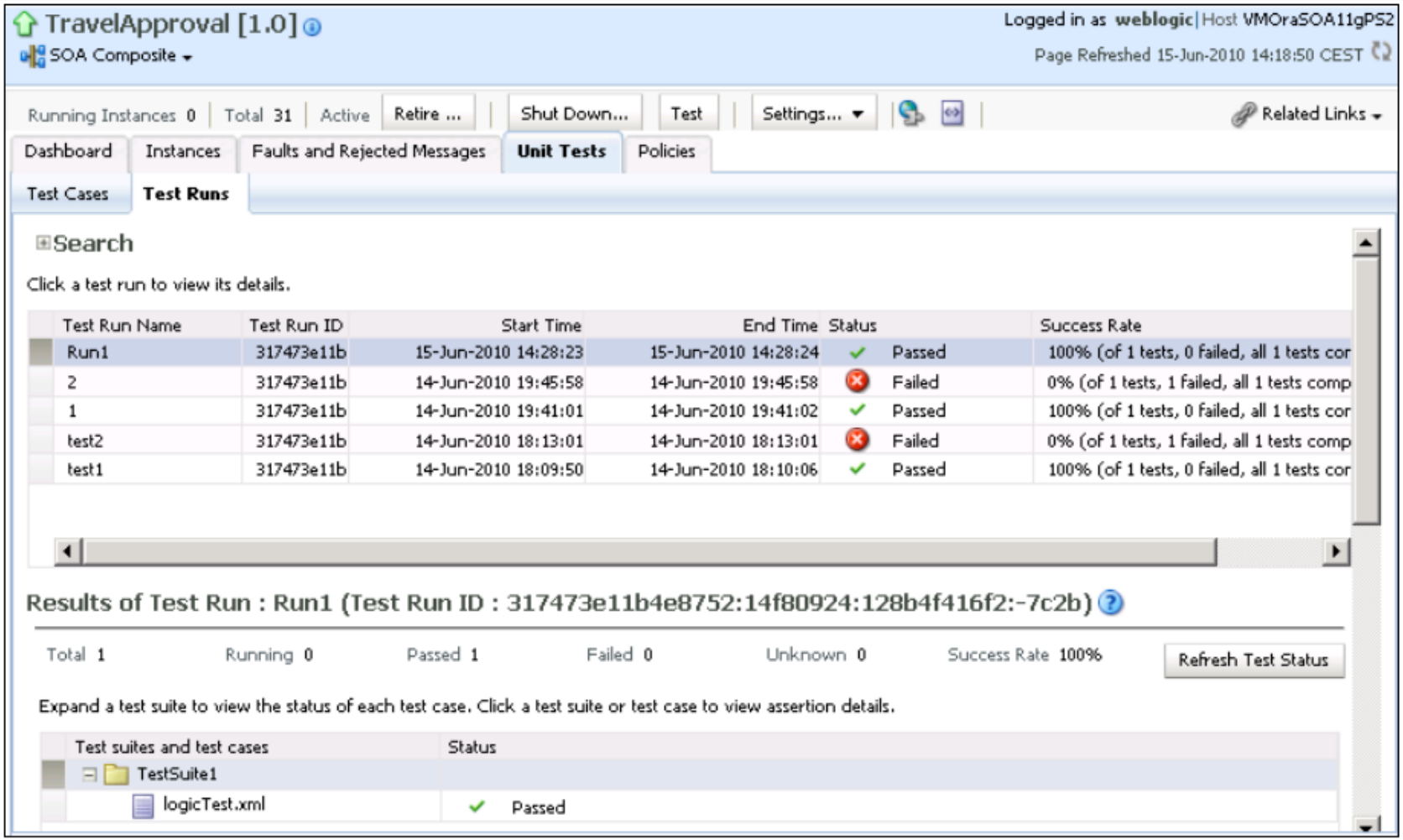


Runtime information





Test suite


TravelApproval [1.0]
SOA Composite
Logged in as weblogic | Host VMOraSOA11gPS2
Page Refreshed 15-Jun-2010 14:18:50 CEST
Running Instances 0 | Total 31 | Active
Retire ...
Shut Down...
Test
Settings...
Related Links
Dashboard
Instances
Faults and Rejected Messages
Unit Tests
Policies
Test Cases
Test Runs
Search
Click a test run to view its details.
Test Run Name | Test Run ID | Start Time | End Time | Status | Success Rate
Run1 | 317473e11b | 15-Jun-2010 14:28:23 | 15-Jun-2010 14:28:24 | Passed | 100% (of 1 tests, 0 failed, all 1 tests cor
2 | 317473e11b | 14-Jun-2010 19:45:58 | 14-Jun-2010 19:45:58 | Failed | 0% (of 1 tests, 1 failed, all 1 tests comp
1 | 317473e11b | 14-Jun-2010 19:41:01 | 14-Jun-2010 19:41:02 | Passed | 100% (of 1 tests, 0 failed, all 1 tests cor
test2 | 317473e11b | 14-Jun-2010 18:13:01 | 14-Jun-2010 18:13:01 | Failed | 0% (of 1 tests, 1 failed, all 1 tests comp
test1 | 317473e11b | 14-Jun-2010 18:09:50 | 14-Jun-2010 18:10:06 | Passed | 100% (of 1 tests, 0 failed, all 1 tests cor
Results of Test Run : Run1 (Test Run ID : 317473e11b4e8752:14f80924:128b4f416f2:-7c2b)
Total 1
Running 0
Passed 1
Failed 0
Unknown 0
Success Rate 100%
Refresh Test Status
Expand a test suite to view the status of each test case. Click a test suite or test case to view assertion details.
Test suites and test cases | Status
TestSuite1
logicTest.xml
Passed

JDeveloepr:

http://www.oracle.com/technetwork/developer-tools/jdev/downloads/index.html

Questions?