PROGRESS
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Artix ESB

Developing Artix Applications with JAX-WS

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Making Software Work Together™

Developing Artix Applications with JAX-WS

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Preface

What is Covered in This Book

This book describes how to use the JAX-WS 2.0 APIs to develop applications with Artix ESB.

Who Should Read This Book

This book is intended for developers using Artix ESB. It assumes that you have a good understanding of the following:

- general programming concepts.
- general SOA concepts.
- Java 5.
- the runtime environment into which you are deploying services.

How to Use This Book

This book is organized into the following chapters:

- *Starting from Java Code* on page 27 describes how to develop SOA applications with out using WSDL documents.
- *Starting from a WSDL Contract* on page 55 describes how to develop SOA applications using a WSDL document as a starting point.
- *Publishing a Service* on page 75 describes how to publish a service using a stand alone Java application.
- *Developing Asynchronous Applications* on page 237 describes how to develop service consumers that can interact with service providers asynchronously.
- *Using Raw XML Messages* on page 251 describes how to use the `Dispatch` and `Provider` interfaces to develop applications that work with raw XML instead of JAXB object.
- *Working with Contexts* on page 275 describes how to manipulate message and transport properties programaticaly.
- *Developing RESTful Services* on page 81 describes how to use the Artix ESB API's annotations to create RESTful services.

The Artix ESB Documentation Library

For information on the organization of the Artix ESB library, the document conventions used, and where to find additional resources, see Using the Artix ESB Library [http://www.iona.com/support/docs/artix/5.1/library_intro/index.htm].

Part I. Basic Programming Tasks

The JAX-WS programming model makes it easy to develop service providers and consumers. You can either start directly with Java code, or you can start from WSDL documents. This part guides you through the steps for creating and publishing endpoints. It also inclludes a chapter on developing services that follow REST principles.

Starting from Java Code

One of the advantages of JAX-WS is that it does not require you to start with a WSDL document that defines their service. You can start with Java code that defines the features you want to expose as services. The code may be a class, or classes, from a legacy application that is being upgraded. It may also be a class that is currently being used as part of a non-distributed application and implements features that you want to use in a distributed manner. You annotate the Java code and generate a WSDL document from the annotated code. If you do not wish to work with WSDL at all, you can create the entire application without ever generating WSDL.

Service Enabling a Java Class

To create a service starting from Java you need to do the following:

1. Create on page 29 a Service Endpoint Interface (SEI) that defines the methods you wish to expose as a service.

   Tip

   You can work directly from a Java class, but working from an interface is the recommended approach. Interfaces are better for sharing with the developers who will be responsible for developing the applications consuming your service. The interface is smaller and does not provide any of the service's implementation details.

2. Add on page 32 the required annotations to your code.
3. Generate on page 44 the WSDL contract for your service.

   Tip

   If you intend to use the SEI as the service's contract, it is not necessary to generate a WSDL contract.

4. Publish on page 75 the service as a service provider.

Creating the SEI

The service endpoint interface (SEI) is the piece of Java code that is shared between a service implementation and the consumers that make requests on it. It defines the methods implemented by the service and provides details about how the service will be exposed as an endpoint. When starting with a WSDL contract, the SEI is generated by the code generators. However, when starting from Java, it is the up to a developer to create the SEI.

There are two basic patterns for creating an SEI:

- Green field development

  You are developing a new service from the ground up. When starting fresh, it is best to start by creating the SEI first. You can then distribute the SEI to any developers that are responsible for implementing the service providers and consumers that use the SEI.

  Note

  The recommended way to do green field service development is to start by creating a WSDL contract that defines the service and its interfaces. See *Starting from a WSDL Contract* on page 55.

- Service enablement

  In this pattern, you typically have an existing set of functionality that is implemented as a Java class and you want to service enable it. This means that you will need to do two things:

  1. Create an SEI that contains **only** the operations that are going to be exposed as part of the service.

  2. Modify the existing Java class so that it implements the SEI.

Note

You can add the JAX-WS annotations to a Java class, but that is not recommended.

Writing the interface

The SEI is a standard Java interface. It defines a set of methods that a class will implement. It can also define a number of member fields and constants to which the implementing class has access.

In the case of an SEI the methods defined are intended to be mapped to operations exposed by a service. The SEI corresponds to a `wsdl:portType` element. The methods defined by the SEI correspond to `wsdl:operation` elements in the `wsdl:portType` element.

Tip

JAX-WS defines an annotation that allows you to specify methods that are not exposed as part of a service. However, the best practice is to leave such methods out of the SEI.

Example 1 on page 30 shows a simple SEI for a stock updating service.

Example 1. Simple SEI

```
package com.iona.demo;

public interface quoteReporter
{
  public Quote getQuote(String ticker);
}
```

Implementing the interface

Because the SEI is a standard Java interface, the class that implements it is just a standard Java class. If you started with a Java class you will need to modify it to implement the interface. If you are starting fresh, the implementation class will need to implement the SEI.

Example 2 on page 31 shows a class for implementing the interface in Example 1 on page 30.

Example 2. Simple Implementation Class

```
package com.iona.demo;

import java.util.*;

public class stockQuoteReporter implements quoteReporter
{
  ...
public Quote getQuote(String ticker)
  {
    Quote retVal = new Quote();
    retVal.setID(ticker);
    retVal.setVal(Board.check(ticker));1
    Date retDate = new Date();
    retVal.setTime(retDate.toString());
    return(retVal);
  }
}
```

[1] `Board` is an assumed class whose implementation is left to the reader.

Annotating the Code

JAX-WS relies on the annotation feature of Java 5. The JAX-WS annotations are used to specify the metadata used to map the SEI to a fully specified service definition. Among the information provided in the annotations are the following:

- The target namespace for the service.
- The name of the class used to hold the request message.
- The name of the class used to hold the response message.
- If an operation is a one way operation.
- The binding style the service uses.
- The name of the class used for any custom exceptions.
- The namespaces under which the types used by the service are defined.

Tip

Most of the annotations have sensible defaults and do not need to be specified. However, the more information you provide in the annotations, the better defined your service definition. A solid service definition increases the likelihood that all parts of a distributed application will work together.

Required Annotations

In order to create a service from Java code you are only required to add one annotation to your code. You must add the `@WebService()` annotation on both the SEI and the implementation class.

The @WebService annotation

The `@WebService` annotation is defined by the `javax.jws.WebService` interface and it is placed on an interface or a class that is intended to be used as a service. `@WebService` has the following properties:

Table 1. `@WebService` Properties

Property	Description
name	Specifies the name of the service interface. This property is mapped to the `name` attribute of the `wsdl:portType` element that defines the service's interface in a WSDL contract. The default is to append `PortType` to the name of the implementation class. [a]
targetNamespace	Specifies the target namespace under which the service is defined. If this property is not specified, the target namespace is derived from the package name.
serviceName	Specifies the name of the published service. This property is mapped to the `name` attribute of the `wsdl:service` element that defines the published service. The default is to use the name of the service's implementation class. [a]
wsdlLocation	Specifies the URI at which the service's WSDL contract is stored. The default is the URI at which the service is deployed.
endpointInterface	Specifies the full name of the SEI that the implementation class implements. This property is only used when the attribute is used on a service implementation class.
portName	Specifies the name of the endpoint at which the service is published. This property is mapped to the `name` attribute of the `wsdl:port` element that specifies the endpoint details for a published service. The default is the append `Port` to the name of the service's implementation class. [a]

[a]When you generate WSDL from an SEI the interface's name is used in place of the implementation class' name.

Tip

You do not need to provide values for any of the `@WebService` annotation's properties. However, it is recommended that you provide as much information as you can.

Annotating the SEI

The SEI requires that you add the `@WebService` annotation. Since the SEI is the contract that defines the service, you should specify as much detail as you can about the service in the `@WebService` annotation's properties.

Example 3 on page 34 shows the interface defined in Example 1 on page 30 with the `@WebService` annotation.

Example 3. Interface with the `@WebService` Annotation

```
package com.iona.demo;

import javax.jws.*;

@WebService(name="quoteUpdater", ❶
            targetNamespace="http:\\demos.iona.com", ❷
         serviceName="updateQuoteService", ❸
            wsdlLocation="http:\\demos.iona.com\quoteExampleService?wsdl", ❹
            portName="updateQuotePort") ❺
public interface quoteReporter
{
  public Quote getQuote(String ticker);
}
```

The `@WebService` annotation in Example 3 on page 34 does the following:

❶ Specifies that the value of the `name` attribute of the `wsdl:portType` element defining the service interface is `quoteUpdater`.

❷ Specifies that the target namespace of the service is `http:\\demos.iona.com`.

❸ Specifies that the value of the `name` of the `wsdl:service` element defining the published service is `updateQuoteService`.

❹ Specifies that the service will publish its WSDL contract at `http:\\demos.iona.com\quoteExampleService?wsdl`.

❺ Specifies that the value of the `name` attribute of the `wsdl:port` element defining the endpoint exposing the service is `updateQuotePort`.

Annotating the service implementation

In addition to annotating the SEI with the `@WebService` annotation, you also have to annotate the service implementation class with the `@WebService` annotation. When adding the annotation to the service implementation class you only need to specify the endpointInterface property. As shown in Example 4 on page 34 the property needs to be set to the full name of the SEI.

Example 4. Annotated Service Implementation Class

```
package org.eric.demo;

import javax.jws.*;
```

```
@WebService(endpointInterface="com.iona.demo.quoteReporter")
public class stockQuoteReporter implements quoteReporter
{
public Quote getQuote(String ticker)
  {
  ...
  }
}
```

Optional Annotations

While the `@WebService` annotation is sufficient for service enabling a Java interface or a Java class, it does not provide a lot of information about how the service will be exposed as a service provider. The JAX-WS programming model uses a number of optional annotations for adding details about your service, such as the binding it uses, to the Java code. You add these annotations to the service's SEI.

Tip

The more details you provide in the SEI the easier it will be for developers to implement applications that can use the functionality it defines. It will also provide for better generated WSDL contracts.

Defining the Binding Properties with Annotations

If you are using a SOAP binding for your service, you can use JAX-WS annotations to specify a number of the bindings properties. These properties correspond directly to the properties you can specify in a service's WSDL contract.

The @SOAPBinding annotation

The `@SOAPBinding` annotation is defined by the `javax.jws.soap.SOAPBinding` interface. It provides details about the SOAP binding used by the service when it is deployed. If the `@SOAPBinding` annotation is not specified, a service is published using a wrapped doc/literal SOAP binding.

You can put the `@SOAPBinding` annotation on the SEI and any of the SEI's methods. When it is used on a method, setting of the method's `@SOAPBinding` annotation take precedence.

Table 2 on page 36 shows the properties for the `@SOAPBinding` annotation.

Table 2. `@SOAPBinding` Properties

Property	Values	Description
style	`Style.DOCUMENT` (default) `Style.RPC`	Specifies the style of the SOAP message. If `RPC` style is specified, each message part within the SOAP body is a parameter or return value and will appear inside a wrapper element within the `soap:body` element. The message parts within the wrapper element correspond to operation parameters and must appear in the same order as the parameters in the operation. If `DOCUMENT` style is specified, the contents of the SOAP body must be a valid XML document, but its form is not as tightly constrained.
use	`Use.LITERAL` (default) `Use.ENCODED`[a]	Specifies how the data of the SOAP message is streamed.
parameterStyle[b]	`ParameterStyle.BARE` `ParameterStyle.WRAPPED` (default)	Specifies how the method parameters, which correspond to message parts in a WSDL contract, are placed into the SOAP message body. A parameter style of `BARE` means that each parameter is placed into the message body as a child element of the message root. A parameter style of `WRAPPED` means that all of the input parameters are wrapped into a single element on a request message and that all of the output parameters are wrapped into a single element in the response message.

[a]`Use.ENCODED` is not currently supported.

[b]If you set the style to `RPC` you must use the `WRAPPED` parameter style.

Example 5 on page 36 shows an SEI that uses rpc/literal SOAP messages.

Example 5. Specifying an RPC/LITERAL SOAP Binding with the `@SOAPBinding` Annotation

```
package org.eric.demo;

import javax.jws.*;
import javax.jws.soap.*;
import javax.jws.soap.SOAPBinding.*;

@WebService(name="quoteReporter")
@SOAPBinding(style=Style.RPC, use=Use.LITERAL)
public interface quoteReporter
{
  ...
}
```

Defining Operation Properties with Annotations

When the runtime maps your Java method definitions into XML operation definitions it fills in details such as:

- what the exchanged messages look like in XML.
- if the message can be optimized as a one way message.
- the namespaces where the messages are defined.

The @WebMethod annotation

The `@WebMethod` annotation is defined by the `javax.jws.WebMethod` interface. It is placed on the methods in the SEI. The `@WebMethod` annotation provides the information that is normally represented in the `wsdl:operation` element describing the operation to which the method is associated.

Table 3 on page 37 describes the properties of the `@WebMethod` annotation.

Table 3. `@WebMethod` Properties

Property	Description
operationName	Specifies the value of the associated `wsdl:operation` element's `name`. The default value is the name of the method.
action	Specifies the value of the `soapAction` attribute of the `soap:operation` element generated for the method. The default value is an empty string.
exclude	Specifies if the method should be excluded from the service interface. The default is `false`.

The @RequestWrapper annotation

The `@RequestWrapper` annotation is defined by the `javax.xml.ws.RequestWrapper` interface. It is placed on the methods in the SEI. As the name implies, `@RequestWrapper` specifies the Java class that implements the wrapper bean for the method parameters that are included in the request message sent in a remote invocation. It is also used to specify the element names, and namespaces, used by the runtime when marshalling and unmarshalling the request messages.

Table 4 on page 38 describes the properties of the `@RequestWrapper` annotation.

Table 4. `@RequestWrapper` Properties

Property	Description
localName	Specifies the local name of the wrapper element in the XML representation of the request message. The default value is the name of the method or the value of the `@WebMethod` annotation's operationName property.
targetNamespace	Specifies the namespace under which the XML wrapper element is defined. The default value is the target namespace of the SEI.
className	Specifies the full name of the Java class that implements the wrapper element.

Tip

Only the className property is required.

The @ResponseWrapper annotation

The `@ResponseWrapper` annotation is defined by the `javax.xml.ws.ResponseWrapper` interface. It is placed on the methods in the SEI. As the name implies, `@ResponseWrapper` specifies the Java class that implements the wrapper bean for the method parameters that are included in the response message sent in a remote invocation. It is also used to specify the element names, and namespaces, used by the runtime when marshalling and unmarshalling the response messages.

Table 5 on page 39 describes the properties of the `@ResponseWrapper` annotation.

Table 5. ***@ResponseWrapper*** ***Properties***

Property	Description
localName	Specifies the local name of the wrapper element in the XML representation of the response message. The default value is the name of the method with `Response` appended or the value of the `@WebMethod` annotation's operationName property with `Response` appended.
targetNamespace	Specifies the namespace under which the XML wrapper element is defined. The default value is the target namespace of the SEI.
className	Specifies the full name of the Java class that implements the wrapper element.

Tip

Only the className property is required.

The @WebFault annotation

The `@WebFault` annotation is defined by the `javax.xml.ws.WebFault` interface. It is placed on exceptions that are thrown by your SEI. The `@WebFault` annotation is used to map the Java exception to a `wsdl:fault` element. This information is used to marshall the exceptions into a representation that can be processed by both the service and its consumers.

Table 6 on page 39 describes the properties of the `@WebFault` annotation.

Table 6. ***@WebFault*** ***Properties***

Property	Description
name	Specifies the local name of the fault element.
targetNamespace	Specifies the namespace under which the fault element is defined. The default value is the target namespace of the SEI.
faultName	Specifies the full name of the Java class that implements the exception.

Important

The name property is required.

The @OneWay annotation

The @OneWay annotation is defined by the javax.jws.OneWay interface. It is placed on the methods in the SEI that will not require a response from the service. The @OneWay annotation tells the run time that it can optimize the execution of the method by not waiting for a response and not reserving any resources to process a response.

Example

Example 6 on page 40 shows an SEI whose methods are annotated.

Example 6. SEI with Annotated Methods

```
package com.iona.demo;

import javax.jws.*;
import javax.xml.ws.*;

@WebService(name="quoteReporter")
public interface quoteReporter
{
  @WebMethod(operationName="getStockQuote")
  @RequestWrapper(targetNamespace="http://demo.iona.com/types",
                  className="java.lang.String")
  @ResponseWrapper(targetNamespace="http://demo.iona.com/types",
                   className="org.eric.demo.Quote")
  public Quote getQuote(String ticker);
}
```

Defining Parameter Properties with Annotations

The method parameters in the SEI corespond to the wsdl:message elements and their wsdl:part elements. JAX-WS provides annotations that allow you to describe the wsdl:part elements that are generated for the method parameters.

The @WebParam annotation

The @WebParam annotation is defined by the javax.jws.WebParam interface. It is placed on the parameters on the methods defined in the SEI. The @WebParam annotation allows you to specify the direction of the parameter, if the parameter will be placed in the SOAP header, and other properties of the generated `wsdl:part`.

Table 7 on page 41 describes the properties of the `@WebParam` annotation.

Table 7. `@WebParam` Properties

Property	**Values**	**Description**
name		Specifies the name of the parameter as it appears in the WSDL. For RPC bindings, this is name of the `wsdl:part` representing the parameter. For document bindings, this is the local name of the XML element representing the parameter. Per the JAX-WS specification, the default is `arg`*`N`*, where *`N`* is replaced with the zero-based argument index (i.e., arg0, arg1, etc.).
targetNamespace		Specifies the namespace for the parameter. It is only used with document bindings where the parameter maps to an XML element. The defaults is to use the service's namespace.

mode	`Mode.IN` (default)
	
	`Mode.OUT`
	
	`Mode.INOUT`
		Specifies the direction of the parameter.

header	`false` (default) `true`	Specifies if the parameter is passed as part of the SOAP header.
partName		Specifies the value of the `name` attribute of the `wsdl:part` element for the parameter when the binding is document.

The @WebResult annotation

The `@WebResult` annotation is defined by the `javax.jws.WebResult` interface. It is placed on the methods defined in the SEI. The `@WebResult` annotation allows you to specify the properties of the generated `wsdl:part` that is generated for the method's return value.

Table 8 on page 42 describes the properties of the `@WebResult` annotation.

Table 8. `@WebResult` Properties

Property	Description
name	Specifies the name of the return value as it appears in the WSDL. For RPC bindings, this is name of the `wsdl:part` representing the return value. For document bindings, this is the local name of the XML element representing the return value. The default value is `return`.
targetNamespace	Specifies the namespace for the return value. It is only used with document bindings where the return value maps to an XML element. The defaults is to use the service's namespace.
header	Specifies if the return value is passed as part of the SOAP header.
partName	Specifies the value of the `name` attribute of the `wsdl:part` element for the return value when the binding is document.

Example

Example 7 on page 42 shows an SEI that is fully annotated.

Example 7. Fully Annotated SEI

```
package com.iona.demo;

import javax.jws.*;
import javax.xml.ws.*;
import javax.jws.soap.*;
import javax.jws.soap.SOAPBinding.*;
import javax.jws.WebParam.*;

@WebService(targetNamespace="http://demo.iona.com",
            name="quoteReporter")
@SOAPBinding(style=Style.RPC, use=Use.LITERAL)
public interface quoteReporter
{
  @WebMethod(operationName="getStockQuote")
  @RequestWrapper(targetNamespace="http://demo.iona.com/types",
                  className="java.lang.String")
  @ResponseWrapper(targetNamespace="http://demo.iona.com/types",
                   className="org.eric.demo.Quote")
  @WebResult(targetNamespace="http://demo.iona.com/types",
             name="updatedQuote")
  public Quote getQuote(
                        @WebParam(targetNamespace="http://demo.iona.com/types",
                                  name="stockTicker",
                                  mode=Mode.IN)
                        String ticker
  );
}
```

Generating WSDL

Once you have annotated your code, you can generate a WSDL contract for your service using the **artix java2wsdl** command. For a detailed listing of options for the **artix java2wsdl** command see artix java2wsdl in the *Artix ESB Command Reference*.

Example

Example 8 on page 44 shows the WSDL contract generated for the SEI shown in Example 7 on page 42.

Example 8. Generated WSDL from an SEI

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions targetNamespace="http://demo.eric.org/"
          xmlns:tns="http://demo.eric.org/"
    xmlns:ns1=""
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:ns2="http://demo.eric.org/types"
    xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
    xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/">
  <wsdl:types>
    <xsd:schema>
      <xs:complexType name="quote">
        <xs:sequence>
          <xs:element name="ID" type="xs:string" minOccurs="0"/>
          <xs:element name="time" type="xs:string" minOccurs="0"/>
          <xs:element name="val" type="xs:float"/>
        </xs:sequence>
      </xs:complexType>
    </xsd:schema>
  </wsdl:types>
  <wsdl:message name="getStockQuote">
    <wsdl:part name="stockTicker" type="xsd:string">
    </wsdl:part>
  </wsdl:message>
  <wsdl:message name="getStockQuoteResponse">
    <wsdl:part name="updatedQuote" type="tns:quote">
    </wsdl:part>
  </wsdl:message>
  <wsdl:portType name="quoteReporter">
    <wsdl:operation name="getStockQuote">
      <wsdl:input name="getQuote" message="tns:getStockQuote">
    </wsdl:input>
      <wsdl:output name="getQuoteResponse" message="tns:getStockQuoteResponse">
    </wsdl:output>
    </wsdl:operation>
  </wsdl:portType>
  <wsdl:binding name="quoteReporterBinding" type="tns:quoteReporter">
    <soap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
    <wsdl:operation name="getStockQuote">
      <soap:operation style="rpc"/>
      <wsdl:input name="getQuote">
        <soap:body use="literal"/>
      </wsdl:input>
      <wsdl:output name="getQuoteResponse">
        <soap:body use="literal"/>
      </wsdl:output>
    </wsdl:operation>
  </wsdl:binding>
  <wsdl:service name="quoteReporterService">
    <wsdl:port name="quoteReporterPort" binding="tns:quoteReporterBinding">
      <soap:address location="http://localhost:9000/quoteReporterService"/>
    </wsdl:port>
  </wsdl:service>
</wsdl:definitions>
```

Developing a Consumer without a WSDL Contract

To create a consumer without a WSDL contract you need to do the following:

1. Create a `Service` object for the service on which the consumer will invoke operations.
2. Add a port to the `Service` object.
3. Get a proxy for the service using the `Service` object's `getPort()` method.
4. Implement the consumer's business logic.

Creating a Service Object

The `javax.xml.ws.Service` class represents the `wsdl:service` element that contains the definition of all of the endpoints that expose a service. As such it provides methods that allow you to get endpoints, defined by `wsdl:port` elements, that are proxies for making remote invocations on a service.

Note

The `Service` class provides the abstractions that allow the client code to work with Java types as opposed to XML documents.

The create() methods

The `Service` class has two static `create()` methods that can be used to create a new `Service` object. As shown in Example 9 on page 47, both of the `create()` methods take the QName of the `wsdl:service` element the `Service` object will represent and one takes a URI specifying the location of the WSDL contract.

Tip

All services publish there WSDL contracts. For SOAP/HTTP services the URI is usually the URI at which the service is published appended with `?wsdl`.

Example 9. `Service create()` Methods

```
public static Service create(URL wsdlLocation,
                             QName serviceName)
  throws WebServiceException;

public static Service create(QName serviceName)
  throws WebServiceException;
```

The value of the *`serviceName`* parameter is a QName. The value of its namespace part is the target namespace of the service. The service's target namespace is specified in the targetNamespace property of the `@WebService` annotation. The value of the QName's local part is the value of `wsdl:service` element's `name` attribute. You can determine this value in a number of ways:

1. It is specified in the serviceName property of the `@WebService` annotation.
2. You append `Service` to the value of the name property of the `@WebService` annotation.
3. You append `Service` to the name of the SEI.

Example

Example 10 on page 48 shows code for creating a `Service` object for the SEI shown in Example 7 on page 42.

Example 10. Creating a `Service` Object

```
package com.iona.demo;

import javax.xml.namespace.QName;
import javax.xml.ws.Service;

public class Client
{
public static void main(String args[])
  {
❶    QName serviceName = new QName("http://demo.iona.com", "stockQuoteReporter");
❷    Service s = Service.create(serviceName);
   ...
  }
}
```

The code in Example 10 on page 48 does the following:

❶ Builds the QName for the service using the targetNamespace property and the name property of the `@WebService` annotation.

❷ Call the single parameter `create()` method to create a new `Service` object.

Note

Using the single parameter `create()` frees you from having any dependencies on accessing an WSDL contract.

Adding a Port to a Service

The endpoint information for a service is defined in a `wsdl:port` element and the `Service` object will create a proxy instance for each of the endpoints defined in a WSDL contract if one is specified. If you do not specify a WSDL contract when you create your `Service` object, the `Service` object has no information about the endpoints that implement your service and cannot create any proxy instances. In this case, you must provide the `Service` object with the information that would be in a `wsdl:port` element using the `addPort()` method.

The addPort() method

The `Service` class defines an `addPort()` method, shown in Example 11 on page 49, that is used in cases where there is no WSDL contract available to the consumer implementation. The `addPort()` method allows you to give a `Service` object the information, which is typically stored in a `wsdl:port` element, needed to create a proxy for a service implementation.

Example 11. The `addPort()` Method

```
void addPort(QName portName,
             String bindingId,
             String endpointAddress)
  throws WebServiceException;
```

The value of the *`portName`* is a QName. The value of its namespace part is the target namespace of the service. The service's target namespace is specified in the targetNamespace property of the `@WebService` annotation. The value of the QName's local part is the value of `wsdl:port` element's `name` attribute. You can determine this value in a number of ways:

1. It is specified in the portName property of the `@WebService` annotation.
2. You append `Port` to the value of the name property of the `@WebService` annotation.
3. You append `Port` to the name of the SEI.

The value of the *bindingId* parameter is a string that uniquely identifies the type of binding used by the endpoint. For a SOAP binding you would use the standard SOAP namespace: `http://schemas.xmlsoap.org/soap/`. If the endpoint is not using a SOAP binding, the value of the *bindingId* parameter will be determined by the binding developer.

The value of the *endpointAddress* parameter is the address at which the endpoint is published. For a SOAP/HTTP endpoint, the address will be an HTTP address. Transports other than HTTP will use different address schemes.

Example

Example 12 on page 50 shows code for adding a port to the `Service` object created in Example 10 on page 48.

Example 12. Adding a Port to a `Service` Object

```
package com.iona.demo;

import javax.xml.namespace.QName;
import javax.xml.ws.Service;

public class Client
{
public static void main(String args[])
  {
    ...
❶    QName portName = new QName("http://demo.iona.com", "stockQuoteReporterPort");
❷    s.addPort(portName,
❸              "http://schemas.xmlsoap.org/soap/",
❹              "http://localhost:9000/StockQuote");
    ...
  }
}
```

The code in Example 12 on page 50 does the following:

❶ Creates the QName for the *portName* parameter.

❷ Calls the `addPort()` method.

❸ Specifies that the endpoint uses a SOAP binding.

❹ Specifies the address at which the endpoint is published.

Getting a Proxy for an Endpoint

A service proxy is an object that provides all of the methods exposed by a remote service and handles all of the details required to make the remote invocations. The `Service` object provides service proxies for all of the endpoints of which it is aware through the `getPort()` method. Once you have a service proxy, you can invoke its methods. The proxy forwards the invocation to the remote service endpoint using the connection details specified in the service's contract.

The getPort() method

The `getPort()` method, shown in Example 13 on page 51, returns a service proxy for the specified endpoint. The returned proxy is of the same class as the SEI.

Example 13. The `getPort()` Method

```
public <T> T getPort(QName portName,
                     Class<T> serviceEndpointInterface)
  throws WebServiceException;
```

The value of the *`portName`* parameter is a QName that identifies the `wsdl:port` element that defines the endpoint for which the proxy is created. The value of the *`serviceEndpointInterface`* parameter is the class of the SEI.

Tip

When you are working without a WSDL contract the value of the *`portName`* parameter is typically the same as the value used for the *`portName`* parameter when calling `addPort()`.

Example

Example 14 on page 51 shows code for getting a service proxy for the endpoint added in Example 12 on page 50.

Example 14. Getting a Service Proxy

```
package com.iona.demo;

import javax.xml.namespace.QName;
import javax.xml.ws.Service;
```

```
public class Client
{
public static void main(String args[])
  {
    ...
    quoteReporter proxy = s.getPort(portName, quoteReporter.class);
    ...
  }
}
```

Implementing the Consumer's Business Logic

Once you a service proxy for a remote endpoint, you can invoke its methods as if it were a local object. The calls will block until the remote method completes.

Note

If a method is annotated with the `@OneWay` annotation, the call will return immediately.

Example

Example 15 on page 53 shows a consumer for the service defined in Example 7 on page 42.

Example 15. Consumer Implemented without a WSDL Contract

```
package com.iona.demo;

import java.io.File;
import java.net.URL;
import javax.xml.namespace.QName;
import javax.xml.ws.Service;

public class Client
{
public static void main(String args[])
  {
    QName serviceName = new QName("http://demo.eric.org", "stockQuoteReporter");
❶   Service s = Service.create(serviceName);

    QName portName = new QName("http://demo.eric.org", "stockQuoteReporterPort");
❷  s.addPort(portName, "http://schemas.xmlsoap.org/soap/", "http://localhost:9000/EricStock
Quote");

❸   quoteReporter proxy = s.getPort(portName, quoteReporter.class);

❹   Quote quote = proxy.getQuote("ALPHA");
    System.out.println("Stock "+quote.getID()+" is worth "+quote.getVal()+" as of
"+quote.getTime());
  }
}
```

The code in Example 15 on page 53 does the following:

❶ Creates a `Service` object.

❷ Adds an endpoint definition to the `Service` object.

❸ Gets a service proxy from the `Service` object.

❹ Invokes an operation on the service proxy.

Starting from a WSDL Contract

The recommended way to develop service-oriented applications is to start from a WSDL contract. The WSDL contract provides an implementation neutral way of defining the operations a service exposes and the data that is exchanged with the service. Artix ESB provides tools to generate JAX-WS annotated starting point code from a WSDL contract. The code generators create all of the classes needed to implement any abstract data types defined in the contract. This approach simplifies the development of widely distributed applications.

A WSDL Contract

Example 16 on page 56 shows the HelloWorld WSDL contract. This contract defines a single interface, `Greeter`, in the `wsdl:portType` element. The contract also defines the endpoint which will implement the service in the `wsdl:port` element.

Example 16. HelloWorld WSDL Contract

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions name="HelloWorld"
                  targetNamespace="http://apache.org/hello_world_soap_http"
                  xmlns="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
                  xmlns:tns="http://apache.org/hello_world_soap_http"
                  xmlns:x1="http://apache.org/hello_world_soap_http/types"
                  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <wsdl:types>
    <schema targetNamespace="http://apache.org/hello_world_soap_http/types"
            xmlns="http://www.w3.org/2001/XMLSchema"
            elementFormDefault="qualified"><element name="sayHi">
        <complexType/>
      </element>
      <element name="sayHiResponse">
        <complexType>
          <sequence>
            <element name="responseType" type="string"/>
          </sequence>
        </complexType>
      </element>
      <element name="greetMe">
        <complexType>
          <sequence>
            <element name="requestType" type="string"/>
          </sequence>
        </complexType>
      </element>
      <element name="greetMeResponse">
        <complexType>
          <sequence>
            <element name="responseType" type="string"/>
          </sequence>
        </complexType>
      </element>
      <element name="greetMeOneWay">
        <complexType>
```

```
          <sequence>
            <element name="requestType" type="string"/>
          </sequence>
        </complexType>
      </element>
      <element name="pingMe">
        <complexType/>
      </element>
      <element name="pingMeResponse">
        <complexType/>
      </element>
      <element name="faultDetail">
        <complexType>
          <sequence>
            <element name="minor" type="short"/>
            <element name="major" type="short"/>
          </sequence>
        </complexType>
      </element>
    </schema>
  </wsdl:types>

  <wsdl:message name="sayHiRequest">
    <wsdl:part element="x1:sayHi" name="in"/>
  </wsdl:message>
  <wsdl:message name="sayHiResponse">
    <wsdl:part element="x1:sayHiResponse" name="out"/>
  </wsdl:message>
  <wsdl:message name="greetMeRequest">
    <wsdl:part element="x1:greetMe" name="in"/>
  </wsdl:message>
  <wsdl:message name="greetMeResponse">
    <wsdl:part element="x1:greetMeResponse" name="out"/>
  </wsdl:message>
  <wsdl:message name="greetMeOneWayRequest">
    <wsdl:part element="x1:greetMeOneWay" name="in"/>
  </wsdl:message>
  <wsdl:message name="pingMeRequest">
    <wsdl:part name="in" element="x1:pingMe"/>
  </wsdl:message>
  <wsdl:message name="pingMeResponse">
    <wsdl:part name="out" element="x1:pingMeResponse"/>
  </wsdl:message>
  <wsdl:message name="pingMeFault">
    <wsdl:part name="faultDetail" element="x1:faultDetail"/>
  </wsdl:message>

  <wsdl:portType name="Greeter">
❶    <wsdl:operation name="sayHi">
```

```
      <wsdl:input message="tns:sayHiRequest" name="sayHiRequest"/>
      <wsdl:output message="tns:sayHiResponse" name="sayHiResponse"/>
    </wsdl:operation>

❷    <wsdl:operation name="greetMe">
      <wsdl:input message="tns:greetMeRequest" name="greetMeRequest"/>
      <wsdl:output message="tns:greetMeResponse" name="greetMeResponse"/>
    </wsdl:operation>

❸    <wsdl:operation name="greetMeOneWay">
      <wsdl:input message="tns:greetMeOneWayRequest" name="greetMeOneWayRequest"/>
    </wsdl:operation>

❹    <wsdl:operation name="pingMe">
      <wsdl:input name="pingMeRequest" message="tns:pingMeRequest"/>
      <wsdl:output name="pingMeResponse" message="tns:pingMeResponse"/>
      <wsdl:fault name="pingMeFault" message="tns:pingMeFault"/>
    </wsdl:operation>
  </wsdl:portType>

  <wsdl:binding name="Greeter_SOAPBinding" type="tns:Greeter">
    ...
  </wsdl:binding>

  <wsdl:service name="SOAPService">
    <wsdl:port binding="tns:Greeter_SOAPBinding" name="SoapPort">
      <soap:address location="http://localhost:9000/SoapContext/SoapPort"/>
    </wsdl:port>
  </wsdl:service>
</wsdl:definitions>
```

The `Greeter` interface defined in Example 16 on page 56 defines the following operations:

❶ sayHi — has a single output parameter, of xsd:string.

❷ greetMe — has an input parameter, of xsd:string, and an output parameter, of xsd:string.

❸ greetMeOneWay — has a single input parameter, of xsd:string. Because this operation has no output parameters, it is optimized to be a oneway invocation (that is, the consumer does not wait for a response from the server).

❹ pingMe — has no input parameters and no output parameters, but it can raise a fault exception.

Developing a Service Starting from a WSDL Contract

Once you have a WSDL document, the process for developing a JAX-WS service provider is three steps:

1. Generate on page 60 starting point code.
2. Implement the service provider's operations.
3. Publish on page 75 the implemented service.

Generating the Starting Point Code

JAX-WS specifies a detailed mapping from a service defined in WSDL to the Java classes that will implement that service as a service provider. The logical interface, defined by the `wsdl:portType` element, is mapped to a service endpoint interface (SEI). Any complex types defined in the WSDL are mapped into Java classes following the mapping defined by the Java Architecture for XML Binding (JAXB) specification. The endpoint defined by the `wsdl:service` element is also generated into a Java class that is used by consumers to access service providers implementing the service.

The **artix wsdl2java** command automates the generation of this code. It also provides options for generating starting point code for your implementation and an ant based makefile to build the application. **artix wsdl2java** provides a number of arguments for controlling the generated code.

Running artix wsdl2java

You can generate the code needed to develop your service provider using the following command:

```
artix wsdl2java -ant -impl -server -d outputDirmyService.wsdl
```

The command does the following:

- The `-ant` argument generates a Ant makefile, called `build.xml`, for your application.
- The `-impl` argument generates a shell implementation class for each `wsdl:portType` element in the WSDL contract.
- The `-server` argument generates a simple `main()` to launch your service provider as a stand alone application.
- The `-d` *`outputDir`* argument tells **artix wsdl2java** to write the generated code to a directory called *`outputDir`*.
- *`myService.wsdl`* is the WSDL contract from which code is generated.

For a complete list of the arguments for **artix wsdl2java** see artix wsdl2java in the *Artix ESB Command Reference*.

Generating code from Ant

If you are using Apache Ant as your build system, you can call the code generator using Ant's **java** task as shown in Example 17 on page 61.

Example 17. Generating Service Starting Point Code from Ant

```
<project name="myProject" basedir=".">
  <property name="my.home" location ="InstallDir"/>

   <path id="my.classpath">
     <fileset dir="${my.home}/lib">
         <include name="*.jar"/>
      </fileset>
   </path>

  <target  name="ServiceGen">
    <java classname="org.apache.cxf.tools.wsdlto.WSDLToJava"
 fork="true">
      <arg value="-ant"/>
      <arg value="-impl"/>
      <arg value="-server"/>
      <arg value="-d"/>
      <arg value="outputDir"/>
      <arg value="myService.wsdl"/>
      <classpath>
        <path refid="my.classpath"/>
      </classpath>
    </java>
    ...
  </target>
  ...
</project>
```

The command line options are passed to the code generator using the task's `arg` element. Arguments that require two strings, such as `-d`, must be split into two `arg` elements.

Generated code

Table 9 on page 62 describes the files generated for creating a service provider.

Table 9. Generated Classes for a Service Provider

File	Description
`portTypeName.java`	The SEI. This file contains the interface your service provider implements. You should not edit this file.
`serviceName.java`	The endpoint. This file contains the Java class consumers will use to make requests on the service.
`portTypeNameImpl.java`	The skeleton implementation class. You will modify this file to build your service provider.
`portTypeNameServer.java`	A basic server mainline that allows you to deploy your service provider as a stand alone process. For more information see *Publishing a Service* on page 75.

In addition, **artix wsdl2java** will generate Java classes for all of the types defined in the WSDL contract.

Generated packages

The generated code is placed into packages based on the namespaces used in the WSDL contract. The classes generated to support the service (based on the `wsdl:portType` element, the `wsdl:service` element, and the `wsdl:port` element) are placed in a package based on the target namespace of the WSDL contract. The classes generated to implement the types defined in the `types` element of the contract are placed in a package based on the `targetNamespace` attribute of the `types` element.

The mapping algorithm is as follows:

1. The leading `http://` or `urn://` are stripped off the namespace.
2. If the first string in the namespace is a valid Internet domain, for example it ends in `.com` or `.gov`, the leading `www.` is stripped off the string, and the two remaining components are flipped.
3. If the final string in the namespace ends with a file extension of the pattern `.xxx` or `.xx`, the extension is stripped.
4. The remaining strings in the namespace are appended to the resulting string and separated by dots.

5. All letters are made lowercase.

Implementing the Service Provider

Once the starting point code is generated, you must provide the business logic for each of the operations defined in the service's interface.

Generating the implementation code

You generate the implementation class used to build your service provider with **wsdl2java**'s `-impl` flag.

Tip

If your service's contract includes any custom types defined in XML Schema, you will also need to ensure that the classes for the types are also generated and available.

Generated code

The implementation code consists of two files:

- *`portTypeName`*`.java` is the service interface(SEI) for the service.
- *`portTypeName`*`Impl.java` is the class you will use to implement the operations defined by the service.

Implement the operation's logic

You provide the business logic for your service's operations by completing the stub methods in *`portTypeName`*`Impl.java`. For the most part, you use standard Java to implement the business logic. If your service uses custom XML Schema types, you will need to use the generated classes for each type to manipulate them. There are also some Artix ESB specific APIs that you can use to access some advanced features.

Example

For example, an implementation class for the service defined in Example 16 on page 56 may look like Example 18 on page 64. Only the code portions highlighted in bold must be inserted by the programmer.

Example 18. Implementation of the Greeter Service

```
package demo.hw.server;

import org.apache.hello_world_soap_http.Greeter;

@javax.jws.WebService(portName = "SoapPort", serviceName = "SOAPService",
                      targetNamespace = "http://apache.org/hello_world_soap_http",
                      endpointInterface = "org.apache.hello_world_soap_http.Greeter")

public class GreeterImpl implements Greeter {

    public String greetMe(String me) {
       System.out.println("Executing operation greetMe");
       System.out.println("Message received: " + me + "\n");
       return "Hello " + me;
    }

    public void greetMeOneWay(String me) {
       System.out.println("Executing operation greetMeOneWay\n");
       System.out.println("Hello there " + me);
    }

    public String sayHi() {
       System.out.println("Executing operation sayHi\n");
       return "Bonjour";
    }

    public void pingMe() throws PingMeFault {
       FaultDetail faultDetail = new FaultDetail();
       faultDetail.setMajor((short)2);
       faultDetail.setMinor((short)1);
       System.out.println("Executing operation pingMe, throwing PingMeFault exception\n");

       throw new PingMeFault("PingMeFault raised by server", faultDetail);
    }
}
```

Developing a Consumer Starting from a WSDL Contract

Generating the Stub Code

You use **artix wsdl2java** to generate the stub code from the WSDL contract. The stub code provides the supporting code that is required to invoke operations on the remote service.

For consumers, **artix wsdl2java** can generate the following kinds of code:

- Stub code — supporting files for implementing a consumer.
- Starting point code — sample code that connects to the remote service and invokes every operation on the remote service.
- Ant build file — a `build.xml` file intended for use with the ant build utility. It has targets for building and for running the sample consumer.

Running artix wsdl2java

You generate consumer code using **artix wsdl2java**. Enter the following command at a command-line prompt:

```
artix wsdl2java -ant -client -d outputDir hello_world.wsdl
```

Where *`outputDir`* is the location of a directory where you would like to put the generated files and `hello_world.wsdl` is a file containing the contract shown in Example 16 on page 56. The `-ant` option generates an ant `build.xml` file, for use with the ant build utility. The `-client` option generates starting point code for the consumer's `main()` method.

For a complete list of the arguments available for **artix wsdl2java** see artix wsdl2java in the *Artix ESB Command Reference*.

Generating code from Ant

If you are using Apache Ant as your build system, you can call the code generator using Ant's **java** task as shown in Example 19 on page 67.

Example 19. Generating Service Starting Point Code from Ant

```
<project name="myProject" basedir=".">
  <property name="fsf.home" location ="InstallDir"/>

   <path id="fsf.classpath">
     <fileset dir="${fsf.home}/lib">
         <include name="*.jar"/>
      </fileset>
   </path>

  <target  name="ServiceGen">
    <java classname="org.apache.cxf.tools.wsdlto.WSDLToJava"
 fork="true">
      <arg value="-ant"/>
      <arg value="-client"/>
      <arg value="-d"/>
      <arg value="outputDir"/>
      <arg value="myService.wsdl"/>
      <classpath>
        <path refid="fsf.classpath"/>
      </classpath>
    </java>
    ...
  </target>
  ...
</project>
```

The command line options are passed to the code generator using the task's `arg` element. Arguments that require two strings, such as `-d`, must be split into two `arg` elements.

Generated code

The preceding command generates the following Java packages:

- `org.apache.hello_world_soap_http`

  This package name is generated from the `http://apache.org/hello_world_soap_http` target namespace. All of the WSDL entities defined in this target namespace (for example, the Greeter port type and the SOAPService service) map to Java classes in the corresponding Java package.

- `org.apache.hello_world_soap_http.types`

  This package name is generated from the `http://apache.org/hello_world_soap_http/types` target namespace. All of the XML types defined in this target namespace (that is, everything defined in the `wsdl:types` element of the HelloWorld contract) map to Java classes in the corresponding Java package.

The stub files generated by **artix wsdl2java** fall into the following categories:

- Classes representing WSDL entities (in the `org.apache.hello_world_soap_http` package) — the following classes are generated to represent WSDL entities:
    - `Greeter` is a Java interface that represents the Greeter `wsdl:portType` element. In JAX-WS terminology, this Java interface is the *service endpoint interface* (SEI).
    - `SOAPService` is a Java service class (extending `javax.xml.ws.Service`) that represents the SOAPService `wsdl:service` element.
    - `PingMeFault` is a Java exception class (extending `java.lang.Exception`) that represents the pingMeFault `wsdl:fault` element.
- Classes representing XML types (in the `org.objectweb.hello_world_soap_http.types` package) — in the HelloWorld example, the only generated types are the various wrappers for the request and reply messages. Some of these data types are useful for the asynchronous invocation model.

Implementing a Consumer

This section describes how to write the code for a simple Java client, based on the WSDL contract from Example 16 on page 56. To implement the consumer, you need to use the following stubs:

- Service class (`SOAPService`).
- SEI (`Greeter`).

Generated service class

Example 20 on page 70 shows the typical outline of a generated service class, *`ServiceName`*`_Service`[1], which extends the `javax.xml.ws.Service` base class.

Example 20. Outline of a Generated Service Class

```
@WebServiceClient(name="..." targetNamespace="..."
                  wsdlLocation="...")
public class ServiceName extends javax.xml.ws.Service
{
  ...
  public ServiceName(URL wsdlLocation, QName serviceName) { }

  public ServiceName() { }

  @WebEndpoint(name="SoapPort")
  public Greeter getPortName() { }
  .
  .
  .
}
```

The `ServiceName` class in Example 20 on page 70 defines the following methods:

- Constructor methods — the following forms of constructor are defined:
  - *`ServiceName`*`(URL wsdlLocation, QName serviceName)` constructs a service object based on the data in the *`ServiceName`* service in the WSDL contract that is obtainable from `wsdlLocation`.

[1]If the `name` attribute of the `wsdl:service` element ends in `Service` the `_Service` is not used.

  - `ServiceName()` is the default constructor, which constructs a service object based on the service name and WSDL contract that were provided at the time the stub code was generated (for example, when running **artix wsdl2java**). Using this constructor presupposes that the WSDL contract remains available at its original location.

- `getPortName()` methods — for every `PortName` port defined on the `ServiceName` service, **artix wsdl2java** generates a corresponding `getPortName()` method in Java. Therefore, a `wsdl:service` element that defines multiple endpoints will generate a service class with multiple `getPortName()` methods.

Service endpoint interface

For every port type defined in the original WSDL contract, you can generate a corresponding SEI. A service endpoint interface is the Java mapping of a `wsdl:portType` element. Each operation defined in the original `wsdl:portType` element maps to a corresponding method in the SEI. The operation's parameters are mapped as follows:

1. The input parameters are mapped to method arguments.

2. The first output parameter is mapped to a return value.

3. If there is more than one output parameter, the second and subsequent output parameters map to method arguments (moreover, the values of these arguments must be passed using Holder types).

For example, Example 21 on page 71 shows the Greeter SEI, which is generated from the `wsdl:portType` element defined in Example 16 on page 56. For simplicity, Example 21 on page 71 omits the standard JAXB and JAX-WS annotations.

Example 21. The Greeter Service Endpoint Interface

```
/* Generated by WSDLToJava Compiler. */

package org.apache.hello_world_soap_http;
  ...
public interface Greeter
{
  public String sayHi();
  public String greetMe(String requestType);
  public void greetMeOneWay(String requestType);
  public void pingMe() throws PingMeFault;
}
```

Consumer main function

Example 22 on page 72 shows the generated code that implements the HelloWorld consumer. The consumer connects to the SoapPort port on the SOAPService service and then proceeds to invoke each of the operations supported by the Greeter port type.

Example 22. Consumer Implementation Code

```
package demo.hw.client;

import java.io.File;
import java.net.URL;
import javax.xml.namespace.QName;
import org.apache.hello_world_soap_http.Greeter;
import org.apache.hello_world_soap_http.PingMeFault;
import org.apache.hello_world_soap_http.SOAPService;

public final class Client {

  private static final QName SERVICE_NAME =
  new QName("http://apache.org/hello_world_soap_http",
            "SOAPService");

  private Client()
  {
  }

  public static void main(String args[]) throws Exception
  {
❶  if (args.length == 0)
    {
      System.out.println("please specify wsdl");
      System.exit(1);
    }

❷  URL wsdlURL;
    File wsdlFile = new File(args[0]);
    if (wsdlFile.exists())
    {
      wsdlURL = wsdlFile.toURL();
    }
    else
    {
      wsdlURL = new URL(args[0]);
    }
    System.out.println(wsdlURL);
❸ SOAPService ss = new SOAPService(wsdlURL,SERVICE_NAME);
❹ Greeter port = ss.getSoapPort();
    String resp;

❺ System.out.println("Invoking sayHi...");
    resp = port.sayHi();
    System.out.println("Server responded with: " + resp);
    System.out.println();

    System.out.println("Invoking greetMe...");
    resp = port.greetMe(System.getProperty("user.name"));
    System.out.println("Server responded with: " + resp);
    System.out.println();

    System.out.println("Invoking greetMeOneWay...");
    port.greetMeOneWay(System.getProperty("user.name"));
    System.out.println("No response from server as method is OneWay");
    System.out.println();

❻ try {
      System.out.println("Invoking pingMe, expecting exception...");
      port.pingMe();
    } catch (PingMeFault ex) {
      System.out.println("Expected exception: PingMeFault has occurred.");
      System.out.println(ex.toString());
    }
    System.exit(0);
  }
}
```

The `Client.main()` method from Example 22 on page 72 proceeds as follows:

❶ The runtime is implicitly initialized — that is, provided the Artix ESB runtime classes are loaded. Hence, there is no need to call a special function in order to initialize Artix ESB.

❷ The consumer expects a single string argument that gives the location of the WSDL contract for HelloWorld. The WSDL contract's location is stored in `wsdlURL`.

❸ You create a service object (passing in the WSDL contract's location and service name).

❹ Call the appropriate `get`*`PortName`*`()` method to obtain an instance of the particular port you need. In this case, the SOAPService service supports only the SoapPort port, which is of Greeter type.

❺ The consumer invokes each of the methods supported by the `Greeter` service endpoint interface.

❻ In the case of the `pingMe()` method, the example code shows how to catch the `PingMeFault` fault exception.

Publishing a Service

When you want to deploy a JAX-WS service as a standalone Java application, you need to write a server mainline. This mainline publishes an endpoint for your service.

Artix ESB provides a number of ways to publish a service as a service provider. How you publish a service depends on the deployment environment you are using. If you are deploying your service into one of the containers supported by Artix ESB you do not need to write any additional code. However, if you are going to deploy your service as a stand-alone Java application, you will need to write a `main()` that publishes the service as a self-contained service provider.

Generating a Server Mainline

The **artix wsdl2java** tool's `-server` flag causes the tool to generate a simple server mainline. The generated server mainline, as shown in Example 23 on page 76, publishes one service provider for each `port` defined in the WSDL contract.

Example

Example 23 on page 76 shows a generated server mainline.

Example 23. Generated Server Mainline

```
package org.apache.hello_world_soap_http;

import javax.xml.ws.Endpoint;

public class GreeterServer {

    protected GreeterServer() throws Exception {
        System.out.println("Starting Server");
❶        Object implementor = new GreeterImpl();
❷        String address = "http://localhost:9000/SoapContext/SoapPort";
❸        Endpoint.publish(address, implementor);
    }

    public static void main(String args[]) throws Exception {
        new GreeterServer();
        System.out.println("Server ready...");

        Thread.sleep(5 * 60 * 1000);
        System.out.println("Server exiting");
        System.exit(0);
    }
}
```

The code in Example 23 on page 76 does the following:

❶ Instantiates a copy of the service implementation object.

❷ Creates the address for the endpoint based on the contents of the `address` child of the `wsdl:port` element in the endpoint's contract.

❸ Publishes the endpoint.

Writing a Server Mainline

If you used the Java first development model or you do not want to use the generated server mainline you can write your own. To write your server mainline you must do the following:

1. Instantiate an `javax.xml.ws.Endpoint` object for the service provider.
2. Create an optional server context to use when publishing the service provider.
3. Publish the service provider using one of the `publish()`.

Instantiating an service provider

You can instantiate an `Endpoint` using one of the following three methods provided by `Endpoint`:

-
  ```
  static Endpoint create(Object implementor);
  ```

  This `create()` method returns an `Endpoint` for the specified service implementation. The created `Endpoint` is created using the information provided by the implementation class'`javax.xml.ws.BindingType` annotation if it is present. If the annotation is not present, the `Endpoint` will use a default SOAP 1.1/HTTP binding.

-
  ```
  static Endpoint create(URI bindingID,
                         Object implementor);
  ```

  This `create()` method returns an `Endpoint` for the specified implementation object using the specified binding. This method overrides the binding information provided by the `javax.xml.ws.BindingType` annotation if it is present. If the *`bindingID`* cannot be resolved, or is `null`, the binding specified in the `javax.xml.ws.BindingType` is used to create the `Endpoint`. If neither the *`bindingID`* or the `javax.xml.ws.BindingType` can be used, the `Endpoint` is created using a default SOAP 1.1/HTTP binding.

-
  ```
  static Endpoint publish(String address,
                          Object implementor);
  ```

The `publish()` method creates an `Endpoint` for the specified implementation and publishes it. The binding used for the `Endpoint` is determined by the URL scheme of the provided *`address`*. The list of bindings available to the implementation are scanned for a binding that supports the URL scheme. If one is found the `Endpoint` is created and published. If one is not found, the method fails.

Tip

Using `publish()` is the same as invoking one of the `create()` methods and then invoking the `publish()` method used to publish to an address on page 78.

Important

The implementation object passed to any of the `Endpoint` creation methods must either be an instance of a class annotated with `javax.jws.WebService` and meeting the requirements for being an SEI implementation or be an instance of a class annotated with `javax.xml.ws.WebServiceProvider` and implementing the `Provider` interface.

Publishing a service provider

You can publish a service provider using one of the following `Endpoint` methods:

- `void publish(String address);`

  This `publish()` method publishes the service provider at the address specified.

Important

The *`address`*'s URL scheme must be compatible with one of the service provider's bindings.

- `void publish(Object serverContext);`

This `publish()` method publishes the service provider based on the information provided in the specified server context. The server context must define an address for the endpoint and it also must be compatible with one of the service provider's available bindings.

Example

Example 24 on page 79 shows code for publishing a service provider.

Example 24. Custom Server Mainline

```
package org.apache.hello_world_soap_http;

import javax.xml.ws.Endpoint;

public class GreeterServer
{
  protected GreeterServer() throws Exception
  {
  }

  public static void main(String args[]) throws Exception
  {
❶    GreeterImpl impl = new GreeterImpl();
❷    Endpoint endpt.create(impl);
❸    endpt.publish("http://localhost:9000/SoapContext/SoapPort");

    boolean done = false;
❹    while(!done)
    {
      ...
    }

    System.exit(0);
  }
}
```

The code in Example 24 on page 79 does the following:

❶ Instantiates a copy of the service's implementation object.

❷ Creates an unpublished `Endpoint` for the service implementation.

❸ Publish the service provider at `http://localhost:9000/SoapContext/SoapPort`.

❹ Loop until the server should be shutdown.

Developing RESTful Services

RESTful services take the concepts of lose coupling and coarse grained interfaces one step farther than standard Web services. Built using the REST architectural style, they rely solely on the four HTTP verbs to access the operations provided by a service. Artix ESB provides a robust mechanism for building RESTful services using straightforward Java classes and annotations.

Introduction to RESTful Services

Overview

Representational State Transfer (REST) is an architectural style first described in a doctoral dissertation by a researcher named Roy Fielding. In REST, servers expose resources using a URI, and clients access these resources using the four HTTP verbs. As clients receive representations of a resource they are placed in a state. When they access a new resource, typically by following a link, they change, or transition, their state. In order to work, REST assumes that resources are capable of being represented using a pervasive standard grammar.

The World Wide Web is the most ubiquitous example of a system designed on REST principles. Web browsers act as clients accessing resources hosted on Web servers. The resources are represented using HTML or XML grammars that all Web browsers can consume. The browsers can also easily follow the links to new resources.

The advantages of REST style systems is that they are highly scalable and highly flexible. Because the resources are accessed and manipulated using the four HTTP verbs, the resources are exposed using a URI, and the resources are represented using standard grammars, clients are not as affected by changes to the servers. Also, REST style systems can take full advantage of the scalability features of HTTP such as caching and proxies.

Basic REST principles

RESTful architectures adhere to the following basic principles:

- Application state and functionality are divided into resources.
- Resources are addressable using standard URIs that can be used as hypermedia links.
- All resources use only the four HTTP verbs.
  - `DELETE`
  - `GET`
  - `POST`
  - `PUT`
- All resources provide information using the MIME types supported by HTTP.

- The protocol is stateless.
- The protocol is cacheable.
- The protocol is layered.

Resources

Resources are central to REST. A resource is a source of information that can be addressed using a URI. In the early days of the Web, resources were largely static documents. In the modern Web, a resource can be any source of information. For example a Web service can be a resource if it can be accessed using a URI.

RESTful endpoints exchange *representations* of the resources they address. A representation is a document containing the data provided by the resource. For example, the method of a Web service that provides access to a customer record wourld be a resource, the copy of the customer record exchanged between the service and the consumer is a representation of the resource.

REST best practices

When designing RESTful services it is helpful to keep in mind the following:

- Provide a distinct URI for each resource you wish to expose.

  For example, if you are building a system that deals with driving records, each record should have a unique URI. If the system also provides information on parking violations and speeding fines, each type of resource should also have a unique base. For example, speeding fines could be accessed through `/speeding/driverID` and parking violations could be accessed through `/parking/driverID`.

- Use nouns in your URIs.

  Using nouns highlights the fact that resources are things and not actions. URIs such as `/ordering` imply an actions, whereas `/orders` implies a thing.

- Methods that map to `GET` should not change any data.

- Use links in your responses.

  Putting links to other resources in your responses makes it easier for clients to follow a chain of data. For example, if your service returns a collection of resources, it would be easier for a client to access each of the individual resources using the provided links. If links are not included, a client needs to have additional logic to follow the chain to a specific node.

- Make your service stateless.

  Requiring the client or the service to maintain state information forces a tight coupling between the two. Tight couplings make upgrading and migrating more difficult. Maintaining state can also make recovery from communication errors more difficult.

Wrapped mode vs. unwrapped mode

RESTful services can only send or receive one XML element. To enable the mapping of methods that use more than one parameter, Artix ESB can use *wrapped mode*. In wrapped mode, Artix ESB wraps the parameters with a root element derived from the operation name. For example, the operation `Car findCar(String make, String model)` could not be mapped to an XML `POST` request like the one shown in Example 25 on page 84.

Example 25. Invalid REST Request

```
<name>Dodge</name>
<model>Daytona</company>
```

Example 25 on page 84 is invalid because it has two root XML elements, which is not allowed. Instead, the parameters would have to be wrapped with the operation name to make the `POST` valid. The resulting request is shown in Example 26 on page 84.

Example 26. Wrapped REST Request

```
<findCar>
  <make>Dodge</make>
  <model>Daytona</model>
</findCar>
```

By default, Artix ESB uses unwrapped mode, because, for cases where operations use a single parameter, it creates prettier XML. Using unwrapped mode, however, requires that you constrain your service interfaces to sending and receiving single elements. If your operation needs to take multiple parameters, you must combine them in an object. With the `findCar()`

example above, you would want to create a `FindCar` class that holds the make and model data.

Implementing REST with Artix ESB

Artix ESB uses an HTTP binding to map Java interfaces into RESTful services. There are two ways to map the methods of the Java interface into resources:

- Convention based mapping (see Using Automatic REST Mappings on page 86)
- Java REST annotations (see Using Java REST Annotations on page 89)

Using Automatic REST Mappings

Overview

To simplify the creation of RESTful service endpoints, Artix ESB can map the methods of a CRUD (Create, Read, Update, and Destroy) based Java bean class to URIs automatically. The mapping looks for keywords in the method names of the bean, such as get, add, update, or remove, and maps them onto HTTP verbs. It then uses the remainder of the method name to create a URI by pluralizing the field name and appending it to the base URI at which the endpoint is published.

Note

For more information about publishing RESTful endpoints, see Publishing a RESTful Service on page 93.

Typical CRUD class

Example 27 on page 86 shows a CRUD based class for updating a catalog of widgets.

Example 27. Widget Catalog CRUD Class

```
import javax.jws.WebService;

@WebService
public interface WidgetCatalog
{
  Collection<Widget> getWidgets();
  Widget getWidget(long id);
  void addWidget(Widget widget);
  void updateWidget(Widget widget);
  void removeWidget(String type, long num);
  void deleteWidget(Widget widget);
}
```

Important

You must use the `@WebService` annotation on any class or interface that you wish to expose as a RESTful endpoint.

The class has six operations that are mapped to a URI/verb pair:

- `getWidgets()` is mapped to a `GET` at *`baseURI`*`/widgets`.

- `getWidget()` is mapped to a `GET` at *`baseURI`*`/widgets/`*`id`*.
- `addWidget()` is mapped to a `POST` at *`baseURI`*`/widgets`.
- `updateWidget()` is mapped to a `PUT` at *`baseURI`*`/widgets`.
- `removeWidget()` is mapped to a `DELETE` at *`baseURI`*`/widgets/`*`type`*`/`*`num`*.
- `deleteWidget()` is mapped to a `DELETE` at *`baseURI`*`/widgets`.

Mapping to GET

When Artix ESB sees a method name in the form of `get`*`Resource`*`()`, it maps the method to a `GET`. The URI is generated by appending the plural form of *`Resource`* to the base URI at which the endpoint is published. If *`Resource`* is already plural, it is not pluralized. For example, `getCustomer()` is mapped to a `GET` on `/customers`. The method `getCustomers()` would result in the same mapping.

Any method parameters are appended to the URI. For example, `getWidget(long id)` is mapped to `/widgets/`*`id`* and `getCar(String make, String model)` would be mapped to `/cars/`*`make`*`/`*`model`*. A call to `getCar(plymouth, roadrunner)` would be executed by a `GET` to `/cars/plymouth/roadrunner`.

Important

Artix ESB only supports get methods that use XML primitives in their parameter list.

Mapping to POST

Methods of the form `add`*`Resource`*`()` or `create`*`Resource`*`()` are mapped to `POST`. The URI is generated by pluralizing *`Resource`*. For example `createCar(Car car)` would be mapped to a `POST` at `/cars`.

Mapping to PUT

Methods of the form `update`*`Resource`*`()` are mapped to `PUT`. The URI is generated by pluralizing *`Resource`* and appending any parameters except the resource to be updated. For example `updateHitter(long number, long` `rotation, Hitter hitter)` would be mapped to a `PUT` at `/hitters/`*`number`*`/`*`rotation`*.

Important

Artix ESB only supports get methods that use XML primitives in their parameter list.

Mapping to DELETE

Methods of the form `delete`*`Resource`*`()` or `remove`*`Resource`*`()` are mapped to `DELETE`. The URI is generated by pluralizing *`Resource`* and appending any parameters. For example `removeCar(String make, long num)` would be mapped to a `DELETE` at `/cars/`*`make`*`/`*`num`*.

Important

Artix ESB only supports get methods that use XML primitives in their parameter list.

Using Java REST Annotations

Overview

While the convention-based REST mappings provide an easy way to create a service that maintains a collection of data, or looks like it does, it does not provide the flexibility to create a full range of RESTful services that require operations whose names don't fit into the CRUD format. Artix ESB provides a collection of annotations that allows you to define the mapping of an operation to an HTTP verb/URI combination. The REST annotations allow you to specify which verb to use for an operation and to specify a template for creating a URI for the exposed resource.

Specifying the HTTP verb

Artix ESB uses four annotations for specifying the HTTP verb that will be used for a method:

- `org.codehaus.jra.Delete` specifies that the method maps to a `DELETE`.
- `org.codehaus.jra.Get` specifies that the method maps to a `GET`.
- `org.codehaus.jra.Post` specifies that the method maps to a `POST`.
- `org.codehaus.jra.Put` specifies that the method maps to a `PUT`.

When you map your methods to HTTP verbs, you must ensure that the mapping makes sense. For example, if you map a method that is intended to submit a purchase order, you would map it to a `PUT` or a `POST`. Mapping it to a `GET` or a `DELETE` would result in unpredictable behavior.

Specifying the URI

You specify the URI of the resource using the `org.codehaus.jra.HttpResource` annotation. `HttpResource` has one required attribute, *`location`*, that specifies the location of the resource in relationship to the base URI specified when publishing the service (see Publishing a RESTful Service on page 93. For example, if you specify `carts` as the location of the resource and the base URI is `http://myexample.iona.org`, the full URI for the resource will be `http://myexample.iona.org/carts`.

Using URI templates

In addition to specifying hard coded resource locations, Artix ESB provides a facility for creating URIs on the fly using either the method's parameters or a field from the JAXB bean in the parameter list. When providing a value for the `HttpResource` annotation's *`location`* parameter you provide a URI template using the syntax in Example 28 on page 90.

Example 28. URI Template Syntax

```
@HttpResource(location="resourceName/{param1}/../{paramN}")
```

`resourceName` can be any valid string, and forms the base of the location. Each *`param`* is the name of either a method parameter or a field in the JAXB bean in the parameter list. To create the URI, Artix ESB replaces *`param`* with the value of the associated parameter. For example, if you have the method shown in Example 29 on page 90 and wanted to access the record at id 42, you would perform a `GET` at `http://myexample.iona.com/records/42`.

Example 29. Using a URI Template

```
@Get
@HttpResource(location="\records\{id}")
Record fetchRecord(long id);
```

Important

Artix ESB only supports XML primitives in URI templates.

Example

If you wanted to implement a system for ordering widgets out of the catalog defined by Example 27 on page 86 you may use an SEI like the one shown in Example 30 on page 90.

Example 30. SEI for a Widget Ordering Service

```
@WebService
public interface WidgetOrdering
{
  void placeOrder(WidgetOrder order);
  OrderStatus checkOrder(long orderNum);
  void changeOrder(WidgetOrder order, long orderNum);
  void cancelOrder(long orderNum);
}
```

`WidgetOrdering` does not match any of the naming conventions outlined in Using Automatic REST Mappings on page 86 so the RESTful binding cannot automatically map the methods to verb/URI combinations. You will need to provide the mappings using the Java REST annotations. To do this, you need to consider what each method in the interface does and how it correlates to one of the HTTP verbs:

- `placeOrder()` creates a new order on the system. Resource creation correlates with `POST`.
- `checkOrder()` looks up an order's status and returns it to the user. Returning resources correlates with `GET`.
- `changeOrder()` updates an order that has already been placed. Updating an existing record correlates with `PUT`.
- `cancelOrder()` removes an order from the system. Removing a resource correlates with `DELETE`.

For the URI, you would use a resource name that hinted at the purpose of the resource. For this example, the resource name used is `orders` because it is assumed that the base URI at which the endpoint is published provides information about what is being ordered. For the methods that use *`orderNum`* to identify a particular order, URI templating is used to append the value of the parameter to the end of the URI.

Example 31 on page 91 shows `WidgetOrdering` with the required annotations.

Example 31. `WidgetOrdering` with REST Annotations

```
import org.codehause.jra.*;

@WebService
public interface WidgetOrdering
{
  @Post
  @HttpResource(location="\orders")
  void placeOrder(WidgetOrder order);

  @Get
  @HttpResource(location="\orders\{orderNum}")
  OrderStatus checkOrder(long orderNum);

  @Put
  @HttpResource(location="\orders\{orderNum}")
  void changeOrder(WidgetOrder order, long orderNum);
  @Delete
  @HttpResource(location="\orders\{orderNum}")
  void cancelOrder(long orderNum);
}
```

To check the status of order number `236`, you would perform a `GET` at *`baseURI`*`/orders/236`.

Publishing a RESTful Service

Overview

You publish RESTful services using the `JaxWsServerFactoryBean` object. Using the `JaxWsServerFactoryBean` object, you specify the base URI for the resources implemented by the service and whether the resources use wrapped messages. You can then create a `Server` object to start listening for requests to access the service's resources.

Procedure

To publish your RESTful service, do the following:

1. Create a new `JaxWsServerFactoryBean`.

2. Set the server factory's service class to the class of your RESTful service's SEI using the factory's `setServiceClass()` method as shown in Example 32 on page 93.

   Example 32. Setting a Server Factory's Service Class

   ```
   // Service factory sf obtained previously
   sf.setServiceClass(widgetService.class);
   ```

3. If you want to use wrapped mode, set the factory's wrapped property to `true` using the `setWrapped()` method as shown in Example 33 on page 93.

   Example 33. Setting Wrapped Mode

   ```
   sf.getServiceFactory().setWrapped(true);
   ```

   Note

   For more information about using wrapped mode or unwrapped mode, see Wrapped mode vs. unwrapped mode on page 84.

4. Set the server factory's binding to the REST binding using the `setBindingId()` method.

The REST binding is selected using the constant `HttpBindingFactory.HTTP_BINDING_ID` as shown in Example 34 on page 94.

Example 34. Selecting the REST Binding

```
// Server factory sf obtained previously
sf.setBindingId(HttpBindingFactory.HTTP_BINDING_ID);
```

5. Set the base URI for the service's resources using the `setAddress()` method as shown in Example 35 on page 94.

Example 35. Setting the Base URI

```
sf.setAddress("http://localhost:9000");
```

6. Set server factory's service invoker to an instance of your service's implementation class as shown in Example 36 on page 94.

Example 36. Setting the Service Invoker

```
widgetService service = new widgetServiceImpl();
sf.getServiceFactory().setInvoker(new BeanInvoker(ser
vice));
```

7. Create a new `Server` object from the server factory using the factory's `create()` method.

Example

Example 37 on page 94 shows the code for publishing a RESTful service at `http://jfu:9000`. All of the resources implemented by the service will use the published URI as the base address.

Example 37. Publishing the WidgetCatalog Service as a RESTful Endpoint

```
JaxWsServerFactoryBean sf = new JaxWsServerFactoryBean();
sf.setServiceClass(WidgetCatalog.class);

sf.setBindingId(HttpBindingFactory.HTTP_BINDING_ID);
sf.setAddress("http://jfu:9000");

widgetService service = new WidgetCatalogImpl();
sf.setServiceFactory.setInvoker(new BeanInvoker(service));
```

```
Server svr = sf.create();
```

If you used Example 37 on page 94 to publish the service defined by Example 27 on page 86, you would:

- Retrieve a list of all widgets in the catalog using a `GET` at `http://jfu:9000/widgets`.
- Retrieve information about widget 34 using a `GET` at `http://jfu:9000/widgets/34`.
- Modify a widget using a `PUT` at `http://jfu:9000/widgets` with an XML document describing the widget to modify.
- Delete 15 round widgets from the catalog using a `DELETE` at `http://jfu:9000/widgets/round/15`.

Part II. Working with Data Types

Service-oriented design abstracts data into a common exchange format. Typically, this format is an XML grammar defined in XML Schema. To save the developer from working directly with XML documents, the JAX-WS specification calls for XML Schema types to be marshaled into Java objects. This marshaling is done in accordance with the Java Architecture for XML Binding (JAXB) specification. JAXB defines bindings for mapping between XML Schema constructs and Java objects and rules for how to marshal the data. It also defines an extensive customization framework for controlling how data is handled.

Basic Data Binding Concepts

There are a number of general topics that apply to how Artix ESB handles type mapping.

Working with External Schema Definitions

Overview

Artix ESB supports the including and importing of schema definitions, using the `<include/>` and `<import/>` schema tags. These tags enable you to insert definitions from external files or resources into the scope of a schema element. The essential difference including and importing is this:

- Including brings in definitions that belong to the same target namespace as the enclosing schema element.
- Importing brings in definitions that belong to a different target namespace from the enclosing schema element.

If you do not need to reference the types defined in a schema document as part of the service definition, you can also generate Java code for a schema document that does not appear in a WSDL. This is useful when using wildcard types.

xsd:include syntax

The include directive has the following syntax:

```
<include schemaLocation="anyURI" />
```

The referenced schema, given by *`anyURI`*, must either belong to the same target namespace as the enclosing schema or not belong to any target namespace at all. If the referenced schema does not belong to any target namespace, it is automatically adopted into the enclosing schema's namespace when it is included.

Example 38 on page 102 shows an example of an XML schema that includes another XML Schema.

Example 38. Example of a Schema that Includes Another Schema

```
<definitions targetNamespace="http://schemas.iona.com/tests/schema_parser"
             xmlns:tns="http://schemas.iona.com/tests/schema_parser"
             xmlns:xsd="http://www.w3.org/2001/XMLSchema"
             xmlns="http://schemas.xmlsoap.org/wsdl/">
  <types>
    <schema targetNamespace="http://schemas.iona.com/tests/schema_parser"
            xmlns="http://www.w3.org/2001/XMLSchema">
      <include schemaLocation="included.xsd"/>
      <complexType name="IncludingSequence">
        <sequence>
          <element name="includedSeq" type="tns:IncludedSequence"/>
        </sequence>
      </complexType>
    </schema>
  </types>
  ...
</definitions>
```

Example 39 on page 103 shows the contents of the included schema file.

Example 39. Example of an Included Schema

```
<schema targetNamespace="http://schemas.iona.com/tests/schema_parser"
        xmlns="http://www.w3.org/2001/XMLSchema">
  <!-- Included type definitions -->
  <complexType name="IncludedSequence">
    <sequence>
      <element name="varInt" type="int"/>
      <element name="varString" type="string"/>
    </sequence>
  </complexType>
</schema>
```

xsd:import syntax

The import directive has the following syntax:

```
<import namespace="namespaceAnyURI"
        schemaLocation="schemaAnyURI" />
```

The imported definitions must belong to the *`namespaceAnyURI target`* namespace. If *`namespaceAnyURI`* is blank or remains unspecified, the imported schema definitions are unqualified.

Example 40 on page 103 shows an example of an XML Schema that imports another XML Schema.

Example 40. Example of a Schema that Includes Another Schema

```
<definitions targetNamespace="http://schemas.iona.com/tests/schema_parser"
             xmlns:tns="http://schemas.iona.com/tests/schema_parser"
             xmlns:xsd="http://www.w3.org/2001/XMLSchema"
             xmlns="http://schemas.xmlsoap.org/wsdl/">
  <types>
    <schema targetNamespace="http://schemas.iona.com/tests/schema_parser"
            xmlns="http://www.w3.org/2001/XMLSchema">
      <import namespace="http://schemas.iona.com/tests/imported_types"
              schemaLocation="included.xsd"/>
      <complexType name="IncludingSequence">
        <sequence>
```

```
          <element name="includedSeq" type="tns:IncludedSequence"/>
        </sequence>
      </complexType>
    </schema>
  </types>
  ...
</definitions>
```

Example 41 on page 104 shows the contents of the imported schema file.

Example 41. Example of an Included Schema

```
<schema targetNamespace="http://schemas.iona.com/tests/imported_types"
        xmlns="http://www.w3.org/2001/XMLSchema">
  <!-- Included type definitions -->
  <complexType name="IncludedSequence">
    <sequence>
      <element name="varInt" type="int"/>
      <element name="varString" type="string"/>
    </sequence>
  </complexType>
</schema>
```

Using non-referenced schema documents

Using types defined in a schema document that is not referenced in the service's WSDL document is a three step process:

1. Convert the schema document to a WSDL document using the **xsd2wsdl** tool.
2. Generate Java for the types using the **artix wsdl2java** tool on the generated WSDL document.

   Important

   You will get a warning from the **artix wsdl2java** tool stating that the WSDL document does not define any services. You can ignore this warning.

3. Add the generated classes to your classpath.

XML Namespace Mapping

Overview

XML Schema type, group, and element definitions are scoped using namespaces. The namespaces prevent possible naming clashes between entities that use the same name. Java packages serve a similar purpose. Therefore, Artix ESB maps the target namespace of a schema document into a package containing the classes needed to implement the structures defined in the XML Schema.

Package naming

The name of the generated package is derived from a schema's target namespace using the following algorithm:

1. The URI scheme, if present, is stripped.

   Note

   Artix ESB will only strip the `http:`, `https:`, and `urn:` schemes.

   For example, the namespace http:\\www.widgetvendor.com\types\widgetTypes.xsd becomes `\\widgetvendor.com\types\widgetTypes.xsd`.

2. The trailing file type identifier, if present, is stripped.

   `\\www.widgetvendor.com\types\widgetTypes.xsd` becomes `\\widgetvendor.com\types\widgetTypes`.

3. The resulting string is broken into a list of strings using `/` and `:` as separators.

   `\\www.widgetvendor.com\types\widgetTypes` becomes the list `{"www.widegetvendor.com", "types", "widgetTypes"}`.

4. If the first string in the list is an internet domain name, it is decomposed as follows:

   a. The leading `www.` is stripped.

   b. The remaining string is split into its component parts using the `.` as the separator.

c. The order of the list is reversed.

`{"www.widegetvendor.com", "types", "widgetTypes"}` becomes `{"com", "widegetvendor", "types", "widgetTypes"}`

Note

Internet domain names end in one of the following: `.com`, `.net`, `.edu`, `.org`, `.gov`, or one of the two-letter country codes.

5. The strings are converted into all lower case.

   `{"com", "widegetvendor", "types", "widgetTypes"}` becomes `{"com", "widegetvendor", "types", "widgettypes"}`.

6. The strings are normalized into valid Java package name components as follows:

   a. If the strings contain any special characters, the special characters are converted to an underscore(_).

   b. If any of the strings are a Java keyword, the keyword is prefixed with an underscore(_).

   c. If any of the strings begin with a numeral, the string is prefixed with an underscore(_).

7. The strings are concatenated using `.` as a separator.

   `{"com", "widegetvendor", "types", "widgettypes"}` becomes the package name `com.widgetvendor.types.widgettypes`.

The XML Schema constructs defined in the namespace http:\\www.widgetvendor.com\types\widgetTypes.xsd are mapped to the Java package `com.widgetvendor.types.widgettypes`.

Package contents

A JAXB generated package contains the following:

- a class implementing each complex type defined in the schema

For more information on complex type mapping see Using Complex Types on page 139.

- an enum type for any simple types defined using the `enumeration` facet

  For more information on how enumerations are mapped see Enumerations on page 128.

- a public `ObjectFactory` class that contains methods for instantiating objects from the schema

  For more information on the `ObjectFactory` class see The Object Factory on page 108.

- a `package-info.java` file that provides metadata about the classes in the package

The Object Factory

Overview

JAXB uses an object factory to provide a mechanism for instantiating instances of JAXB generated constructs. The object factory contains methods for instantiating all of the XML schema defined constructs in the package's scope. The only exception is that enumerations do not get a creation method in the object factory.

Complex type factory methods

For each Java class generated to implement an XML schema complex type, the object factory contains a method for creating an instance of the class. This method takes the form:

```
typeName createtypeName();
```

For example, if your schema contained a complex type named `widgetType`, Artix ESB will generate a class called `WidgetType` to implement it. Example 42 on page 108 shows the generated creation method in the object factory.

Example 42. Complex Type Object Factory Entry

```
public class ObjectFactory
{
  ...
  WidgetType createWidgetType()
  {
    return new WidgetType();
  }
  ...
}
```

Element factory methods

For elements that are declared in the schema's global scope, Artix ESB inserts a factory method into the object factory. As discussed in Using XML Elements on page 115, XML Schema elements are mapped to `JAXBElement<T>` objects. The creation method takes the form:

```
public JAXBElement<elementType> createelementName(elementType
value);
```

For example if you had an element named `comment` that was of type xsd:string, Artix ESB would generate the object factory method shown in Example 43 on page 109

Example 43. Element Object Factory Entry

```
public class ObjectFactory
{
  ...
    @XmlElementDecl(namespace = "...", name = "comment")
    public JAXBElement<String> createComment(String value) {
        return new JAXBElement<String>(_Comment_QNAME, String.class, null, value);
    }
  ...
}
```

Adding Classes to the Runtime Marshaller

Overview

When the Artix ESB runtime reads and writes XML data it uses a map that associates the XML Schema types with their representative Java types. By default, the map contains all of the types defined in the target namespace of the WSDL contract's `schema` element. This can pose a problem when using type and element substitution. You may substitute an element defined in an alternate namespace for one in the target namesapce. If the runtime does not now about the Java class supporting the error, it will raise a marshaling error.

The addition of types from namespaces other than the schema namespace used by an application's `schema` element can be accomplished by either configuration properties or by programmatic means .

Configuring an endpoint to load extra classes

You configure the Artix ESB runtime to load extra classes by adding the extraClasses to your server's `org.apache.cxf.jaxb.JAXBDataBinding` bean. This is shown in Example 44 on page 110.

Example 44. Syntax for Configuring a Server to Load Extra JAXB Classes

```
<jaxws:server ...>
  <jaxws:dataBinding>
      <bean class="org.apache.cxf.jaxb.JAXBDataBinding">
        <property name="extraClass">
          <list>
            <value>class1</value>
            <value>class2</value>
             ...
            <value>classN</value>
          </list>
        </property>
      </bean>
    </jaxws:dataBinding>
</jaxws:server>
```

The runtime will load the listed classes and add them to the endpoint's JAXB context. Once added to the JAXB context, the classes will be available for marshaling and unmarshaling data.

You can also add the extraClasses property to your client's `org.apache.cxf.jaxb.JAXBDataBinding` bean..

Example 45 on page 111 shows an example of configuring a JAX-WS client to load extra classes.

Example 45. Configuring a JAX-WS Client to Load Extra JAXB Classes

```
<jaxws:client ...>
  <jaxws:dataBinding>
      <bean class="org.apache.cxf.jaxb.JAXBDataBinding">
        <property name="extraClass">
          <list>
            <value>class1</value>
            <value>class2</value>
             ...
            <value>classN</value>
          </list>
        </property>
      </bean>
    </jaxws:dataBinding>
</jaxws:client>
```

Programmatically adding classes to a service provider

You programatically add extra classes to the JAXB context to a service provider using an `org.apache.cxf.jaxws.JaxWsServerFactoryBean` object and adding the jaxb.additionalContextClasses property to it. The jaxb.additionalContextClasses property takes an array of `Class` objects. Each `Class` object in the array will be added to the JAXB context and will be available for marshaling.

Example 46 on page 111 shows code for adding extra classes to the JAXB context.

Example 46. Adding Classes to a Service Provider

```
import org.apache.cxf.jaxws.*;
...
wsdlURL = new URL(args[0]);
String address = "http://localhost:9000/SoapContext/WidgetPort";

JaxWsServerFactoryBean sf = new JaxWsServerFactoryBean(); ❶
...
Map props = sf.getProperties(); ❷
if (props == null)
  {
    props = new HashMap<String, Object>();
  }
props.put("jaxb.additionalContextClasses",
           new Class[] {org.apache.cxf.systest.jaxb.model.ExtendedWidget.class}); ❸
sf.setProperties(props); ❹

sf.setWsdlURL(wsdlURL.toString()); ❺
sf.setAddress(address); ❻
sf.setServiceClass(WidgetImpl.class); ❼
sf.setServiceBean(new WidgetImpl()); ❽
sf.setStart(false); ❾
Server server = sf.create(); ❿
server.start(); 11
```

The code in Example 46 on page 111 does the following:

❶ Instantiates a JAX-WS server factory.

❷ Gets the properties set on the server factory.

❸ Adds the jaxb.additionalContextClasses property to the server factory's property map.

The jaxb.additionalContextClasses property takes an array of Java `Class` objects.

❹ Sets the updated property list back on the server factory.

❺ Sets the location of the WSDL document.

❻ Sets the address.

❼ Sets the implementation class.

❽ Sets the service bean to an instance of the implementation class.

❾ Tells the factory not to start the server when it is created.

❿ Creates a new `Server` object from the factory.

11 Calls the server's `start()` method so it can start listening for requests.

Programmatically adding classes to a service consumer

You programatically add extra classes to the JAXB context to a service consumer using an `org.apache.cxf.jaxws.JaxWsProxyFactoryBean` object and adding the jaxb.additionalContextClasses property to it. The jaxb.additionalContextClasses property takes an array of `Class` objects. Each `Class` object in the array will be added to the JAXB context and will be available for marshaling.

You will need to use the `JaxWsProxyFactoryBean` object you created to instantiate any proxies that need to have access to the additional classes.

You can create proxies using the factory's `create()` method and casting the result to the appropriate class.

Example 47 on page 113 shows code for adding extra classes to the JAXB context.

Example 47. Adding Classes to a Service Consumer

```
import org.apache.cxf.jaxws.*;
...
QName SERVICE_NAME  = new QName("http://apache.org/widget_example", "WidgetService");
wsdlURL = new URL(args[0]);

JaxWsProxyFactoryBean pf = new JaxWsProxyFactoryBean(); ❶

Map props = sf.getProperties(); ❷
if (props == null)
  {
    props = new HashMap<String, Object>();
  }
props.put("jaxb.additionalContextClasses",
            new Class[] {org.apache.cxf.systest.jaxb.model.ExtendedWidget.class}); ❸
pf.setProperties(props); ❹
...
pf.setWsdlURL(wsdlURL.toString()); ❺
pf.setServiceClass(WidgetConsumer.class); ❻
pf.setServiceName(SERVICE_NAME); ❼
WidgetConsumer proxy = (WidgetConsumer)pf.create(); ❽
```

The code in Example 47 on page 113 does the following:

❶ Instantiates a JAX-WS proxy factory.

❷ Gets the properties set on the proxy factory.

❸ Adds the jaxb.additionalContextClasses property to the proxy factory's property map.

The jaxb.additionalContextClasses property takes an array of Java `Class` objects.

❹ Sets the updated property list back on the proxy factory.

❺ Sets the location of the WSDL document.

❻ Sets the SEI class.

❼ Sets the name of the service.

❽ Creates a new proxy object from the factory.

More information

For more information on using Artix ESB configuration see Configuring and Deploying Artix Solutions, Java Runtime [http://www.iona.com/support/docs/artix/5.1/deploy/java/index.htm].

Using XML Elements

XML Schema elements are used to define an instance of an element in an XML document. Elements are defined either in the global scope of an XML Schema document or they are defined as a member of a complex type. When they are defined in the global scope, Artix ESB maps them to a JAXB element class that makes manipulating them easier.

Overview

An element instance in an XML document is defined by an XML Schema `element` element in the global scope of an XML Schema document. To make it easier for Java developers to work with elements, Artix ESB maps globally scoped elements to either a special JAXB element class or to a Java class that is generated to match its content type.

How the element is mapped depends on if the element is defined using a named type referenced by the `type` attribute or if the element is defined using an in-line type definition. Elements defined with in-line type definitions are mapped to Java classes.

Tip

It is recommended that elements are defined using a named type because in-line types are not reusable by other elements in the schema.

XML Schema mapping

In XML Schema elements are defined using `element` elements. `element` elements has one required attribute. The `name` specifies the name of the element as it will appear in an XML document.

In addition to the `name` attribute `element` elements have the optional attributes listed in Table 10 on page 115

Table 10. Attributes Used to Define an Element

Attribute	Description
`type`	Specifies the type of the element. The type can be any XML Schema primitive type or any named complex type defined in the contract. If this attribute is not specified, you will need to include an in-line type definition.

Attribute	Description
`nillable`	Specifies if an element can be left out of a document entirely. If `nillable` is set to `true`, the element can be omitted from any document generated using the schema.
`abstract`	Specifies if an element can be used in an instance document. `true` indicates that the element cannot appear in the instance document. Instead, another element whose `substitutionGroup` attribute contains the QName of this element must appear in this element's place. For information on how this attribute effects code generation see Java mapping of abstract elements on page 119.
`substitutionGroup`	Specifies the name of an element that can be substituted with this element. For more information on using type substitution see Using Type Substitution on page 185.
`default`	Specifies a default value for an element. For information on how this attribute effects code generation see Java mapping of elements with a default value on page 120.
`fixed`	Specifies a fixed value for the element.

Example 48 on page 116 shows a simple element definition.

Example 48. Simple XML Schema Element Definition

```
<element name="joeFred" type="xsd:string" />
```

An element can also define its own type using an in-line type definition. In-line types are specified using either a `complexType` element or a `simpleType` element. Once you specify if the type of data is complex or simple, you can define any type of data needed using the tools available for each type of data.

Example 49 on page 116 shows an element definition with an in-line type definition.

Example 49. XML Schema Element Definition with an In-Line Type

```
<element name="skate">
  <complexType>
    <sequence>
      <element name="numWheels" type="xsd:int" />
      <element name="brand" type="xsd:string" />
    </sequence>
  </complexType>
</element>
```

Java mapping of elements with a named type

By default, globally defined elements are mapped to `JAXBElement<T>` objects where the template class is determined by the value of the `element` element's `type` attribute. For primitive types, the template class is derived using the wrapper class mapping described in Wrapper classes on page 123. For complex types, the Java class generated to support the complex type is used as the template class.

To support the mapping and relieve the developer of needing to worry about an element's QName, an object factory method is generated for each globally defined element as shown in Example 50 on page 117.

Example 50. Object Factory Method for a Globally Scoped Element

```
public class ObjectFactory {

    private final static QName _name_QNAME = new QName("targetNamespace", "localName");

  ...

   @XmlElementDecl(namespace = "targetNamespace", name = "localName")
    public JAXBElement<type> createname(type value);

}
```

For example the element defined in Example 48 on page 116 would result in the object factory method shown in Example 51 on page 117.

Example 51. Object Factory for a Simple Element

```
public class ObjectFactory {

    private final static QName _JoeFred_QNAME = new QName("...", "joeFred");

  ...

   @XmlElementDecl(namespace = "...", name = "joeFred")
    public JAXBElement<String> createJoeFred(String value);

}
```

Example 52 on page 118 shows an example of using a globally scoped element in Java.

Example 52. Using a Globally Scoped Element

```
JAXBElement<String> element = createJoeFred("Green");
String color = element.getValue();
```

Using elements with named types in WSDL

If a globally scoped element is used to define a message part, the generated Java parameter is not an instance of `JAXBElement<T>`. Instead it is mapped to a regular Java type or class.

Given the WSDL fragment shown in Example 53 on page 118, the resulting method would have a parameter of type String.

Example 53. WSDL Using an Element as a Message Part

```
<?xml version="1.0" encoding=";UTF-8"?>
<wsdl:definitions name="HelloWorld"
                  targetNamespace="http://apache.org/hello_world_soap_http"
                  xmlns="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
                  xmlns:tns="http://apache.org/hello_world_soap_http"
                  xmlns:x1="http://apache.org/hello_world_soap_http/types"
                  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <wsdl:types>
    <schema targetNamespace="http://apache.org/hello_world_soap_http/types"
            xmlns="http://www.w3.org/2001/XMLSchema"
            elementFormDefault="qualified"><element name="sayHi">
      <element name="sayHi" type="string"/>
      <element name="sayHiResponse" type="string"/>
    </schema>
  </wsdl:types>

  <wsdl:message name="sayHiRequest">
    <wsdl:part element="x1:sayHi" name="in"/>
  </wsdl:message>
  <wsdl:message name="sayHiResponse">
    <wsdl:part element="x1:sayHiResponse" name="out"/>
  </wsdl:message>

  <wsdl:portType name="Greeter">
    <wsdl:operation name="sayHi">
      <wsdl:input message="tns:sayHiRequest" name="sayHiRequest"/>
      <wsdl:output message="tns:sayHiResponse" name="sayHiResponse"/>
    </wsdl:operation>
  </wsdl:portType>
  ...
</wsdl:definitions>
```

Example 54 on page 119 shows the generated method signature for the `sayHi` operation.

Example 54. Java Method Using a Global Element as a Part

```
String sayHi(String in);
```

Java mapping of elements with an in-line type

When an element is defined using an in-line type, it is mapped to Java following the same rules used for mapping other types to Java. The rules for simple types are described in Using Simple Types on page 121. The rules for complex types are described in Using Complex Types on page 139.

When a Java class is generated for an element with an in-line type definition, the generated class is decorated with the `@XmlRootElement` annotation. The `@XmlRootElement` annotation has two useful properties: name and namespace. These attributes are described in Table 11 on page 119.

Table 11. Properties for the @XmlRootElement Annotation

Property	Description
name	Specifies the value of the XML Schema `element` element's `name` attribute.
namespace	Specifies the namespace in which the element is defined. If this element is defined in the target namespace, the property is not specified.

The `@XmlRootElement` annotation is not used if the element meets one or more of the following conditions:

- the element's `nillable` attribute is set to `true`.
- the element is the head element of a substitution group.

  For more information on substitution groups see *Using Type Substitution* on page 185.

Java mapping of abstract elements

When the element's `abstract` attribute is set to `true` the object factory method for instantiating instances of the type is not generated. If the element is defined using an in-line type, the Java class supporting the in-line type will be generated.

Java mapping of elements with a default value

When the element's `default` attribute is used the defaultValue property is added to the generated `@XmlElementDecl` annotation. For example, the element defined in Example 55 on page 120 would result in the object factory method shown in Example 56 on page 120.

Example 55. XML Schema Element with a Default Value

```
<element name="size" type="xsd:int" default="7"/>
```

Example 56. Object Factory Method for an Element with a Default Value

```
@XmlElementDecl(namespace = "...", name = "size", defaultValue = "7")
    public JAXBElement<Integer> createUnionJoe(Integer value) {
        return new JAXBElement<Integer>(_Size_QNAME, Integer.class, null, value);
    }
```

Using Simple Types

XML Schema simple types are either XML Schema primitive types like xsd:int or are defined using the `simpleType` element. They are used to specify elements that do not contain any children or attributes. They are generally mapped to native Java constructs and do not require the generation of special classes to implement them. Enumerated simple types do result in generated code because they are mapped to Java enum types.

Primitive Types

Overview

When a message part is defined using one of the XML Schema primitive types, the generated parameter's type is mapped to a corresponding Java native type. The same pattern is used when mapping elements that are defined within the scope of a complex type. The resulting field will be of the corresponding Java native type.

Mappings

Table 12 on page 122 lists the mapping between XML Schema primitive types and Java native types.

Table 12. XML Schema Primitive Type to Java Native Type Mapping

XML Schema Type	Java Type
xsd:string	`String`
xsd:integer	`BigInteger`
xsd:int	int
xsd:long	long
xsd:short	short
xsd:decimal	`BigDecimal`
xsd:float	float
xsd:double	double
xsd:boolean	boolean
xsd:byte	byte
xsd:QName	`QName`
xsd:dateTime	`XMLGregorianCalendar`
xsd:base64Binary	byte[]
xsd:hexBinary	byte[]
xsd:unsignedInt	long
xsd:unsignedShort	int
xsd:unsignedByte	short
xsd:time	`XMLGregorianCalendar`

XML Schema Type	Java Type
xsd:date	`XMLGregorianCalendar`
xsd:g	`XMLGregorianCalendar`
xsd:anySimpleType [a]	`Object`
xsd:anySimpleType [b]	`String`
xsd:duration	`Duration`
xsd:NOTATION	`QName`

[a]For elements of this type.
[b]For attributes of this type.

Wrapper classes

Mapping XML Schema primitive types to Java primitives does not work for all possible XML Schema constructs. Several cases require that an XML Schema primitive type is mapped to the Java primitive's corresponding wrapper type. These cases include:

- an `element` element with its `nillable` attribute set to `true` as shown in bellow:

  ```
  <element name="finned" type="xsd:boolean"
           nillable="true" />
  ```

- an `element` element with its `minOccurs` attribute set to `0` and its `maxOccurs` attribute set to `1` or its `maxOccurs` attribute not specified as shown below:

  ```
  <element name="plane" type="xsd:string" minOccurs="0" />
  ```

- an `attribute` element with its `use` attribute set to `optional`, or not specified, and having neither its `default` attribute nor its `fixed` attribute specified as shown in bellow:

  ```
  <element name="date">
    <complexType>
      <sequence/>
      <attribute name="calType" type="xsd:string"
                 use="optional" />
  ```

```
  </complexType>
</element>
```

Table 13 on page 124 shows how XML Schema primitive types are mapped into Java wrapper classes in these cases.

Table 13. Primitive Schema Type to Java Wrapper Class Mapping

Schema Type	Java Type
xsd:int	`java.lang.Integer`
xsd:long	`java.lang.Long`
xsd:short	`java.lang.Short`
xsd:float	`java.lang.Float`
xsd:double	`java.lang.Double`
xsd:boolean	`java.lang.Boolean`
xsd:byte	`java.lang.Byte`
xsd:unsignedByte	`java.lang.Short`
xsd:unsignedShort	`java.lang.Integer`
xsd:unsignedInt	`java.lang.Long`
xsd:unsignedLong	`java.math.BigInteger`
xsd:duration	`java.lang.String`

Simple Types Defined by Restriction

Overview

XML Schema allows you to create simple types by deriving a new type from another primitive type or simple type. Simple types are described using a `simpleType` element.

The new types are described by restricting the *base type* with one or more of a number of facets. These facets limit the possible valid values that can be stored in the new type. For example, you could define a simple type, SSN, which is a string of exactly 9 characters.

Each of the primitive XML Schema types has their own set of optional facets.

Procedure

To define your own simple type do the following:

1. Determine the base type for your new simple type.
2. Based on the available facets for the chosen base type, determine what restrictions define the new type.
3. Using the syntax shown in this section, enter the appropriate simpleType element into the types section of your contract.

Defining a simple type in XML Schema

Example 57 on page 125 shows the syntax for describing a simple type.

Example 57. Simple Type Syntax

```
<simpleType name="typeName">
  <restriction base="baseType">
    <facet value="value" />
    <facet value="value" />
    ...
  </restriction>
</simpleType>
```

The type description is enclosed in a `simpleType` element and identified by the value of the `name` attribute. The base type from which the new simple type is being defined is specified by the `base` attribute of the `xsd:restriction` element. Each facet element is specified within the `restriction` element. The available facets and their valid setting depends on the base type. For example, xsd:string has six facets including:

- `length`
- `minLength`
- `maxLength`
- `pattern`
- `whitespace`

Example 58 on page 126 shows the definition for a simple type that represents the two-letter postal code used for US states. It can only contain two, uppercase letters. `TX` would be a valid value, but `tx` or `tX` would not be valid values.

Example 58. Postal Code Simple Type

```
<xsd:simpleType name="postalCode">
  <xsd:restriction base="xsd:string">
    <xsd:pattern value="[A-Z]{2}" />
  </xsd:restriction>
</xsd:simpleType>
```

Mapping to Java

Artix ESB maps user-defined simple types to the Java type of the simple type's base type. So, any message using the simple type postalCode, shown in Example 58 on page 126, would be mapped to a `String` because the base type of postalCode is s. For example, the WSDL fragment shown in Example 59 on page 126 would result in a Java method, `state()`, which took a parameter, *`postalCode`*, of `String`.

Example 59. Credit Request with Simple Types

```
<message name="stateRequest">
  <part name="postalCode" type="postalCode" />
</message>
...
<portType name="postalSupport">
  <operation name="state">
    <input message="tns:stateRequest" name="stateRec" />
    <output message="tns:stateResponse" name="credResp" />
  </operation>
</portType>
```

Enforcing facets

By default, Artix ESB does not enforce any of the facets than can be used to restrict a simple type. However, you can configure Artix ESB endpoints to enforce the facets by enabling schema validation.

You configure Artix ESB endpoints to use schema validation by setting their schema-validation-enabled property to true. Example 60 on page 127 shows the configuration for a provider that uses schema validation

Example 60. Provider Configured to Use Schema Validation

```
<jaxws:endpoint name="{http://apache.org/hello_world_soap_http}SoapPort"
                wsdlLocation="wsdl/hello_world.wsdl"
                createdFromAPI="true">
  <jaxws:properties>
    <entry key="schema-validation-enabled" value="true" />
  </jaxws:properties>
</jaxws:endpoint>
```

For more information on configuring Artix ESB see ????.

Enumerations

Overview

In XML Schema enumerated types are simple types that are defined using the `xsd:enumeration` facet. Unlike atomic simple types, they are mapped into Java enums.

Defining an enumerated type in XML Schema

Enumerations are a simple type using the `xsd:enumeration` facet. Each `xsd:enumeration` facet defines one possible value for the enumerated type.

Example 61 on page 128 shows the definition for an enumerated type. It has the possible values: `big`, `large`, `mungo`, and `gargantuan`.

Example 61. XML Schema Defined Enumeration

```
<simpleType name="widgetSize">
  <restriction base="xsd:string">
    <enumeration value="big"/>
    <enumeration value="large"/>
    <enumeration value="mungo"/>
    <enumeration value="gargantuan"/>
  </restriction>
```

Mapping to Java

XML Schema enumerations whose base type is xsd:string are automatically mapped into Java enum type. You can instruct the code generator to map enumerations with other base types to Java enum types by using the customizations described in Customizing Enumeration Mapping on page 221.

The enum type is created as follows:

1. The name of the type is taken from the `name` attribute of the simple type definition and converted to a Java identifier.

   In general this means converting the first character of the XML Schema's name to an uppercase letter. If the first character of the XML Schema's name is an invalid character, an underscrore (_) is prepended to the name.

2. For each `enumeration` facet, an enum constant is generated based on the value of the `value` attribute.

The constant's name is derived by converting all of the lowercase letters in the value to their uppercase equivalent.

3. A constructor is generated that takes the Java type mapped from the enumeration's base type.
4. A public method called `value()` is generated to access the facet value that is represented by an instance of the type.

   The return type of the `value()` method is the base type of the XML Schema type.
5. A public method called `fromValue()` is generated to create an instance of the enum type based on a facet value.

   The parameter type of the `value()` method is the base type of the XML Schema type.
6. The class is decorated with the `@XmlEnum` annotation.

The enumerated type defined in Example 61 on page 128 would be mapped to the enum type shown in Example 62 on page 129.

Example 62. Generated Enumerated Type for a String Bases XML Schema Enumeration

```
@XmlType(name = "widgetSize")
@XmlEnum
public enum WidgetSize {

    @XmlEnumValue("big")
    BIG("big"),
    @XmlEnumValue("large")
    LARGE("large"),
    @XmlEnumValue("mungo")
    MUNGO("mungo"),
    @XmlEnumValue("gargantuan")
    GARGANTUAN("gargantuan");
    private final String value;

    WidgetSize(String v) {
        value = v;
    }

    public String value() {
        return value;
    }

    public static WidgetSize fromValue(String v) {
        for (WidgetSize c: WidgetSize.values()) {
            if (c.value.equals(v)) {
                return c;
            }
        }
        throw new IllegalArgumentException(v);
    }

}
```

Lists

Overview

XML Schema supports a mechanism for defining data types that are a list of space separated simple types. An example of an element, `primeList`, using a list type is shown in Example 63 on page 131.

Example 63. List Type Example

```
<primeList>1 3 5 7 9 11 13<\primeList>
```

XML Schema list types are generally mapped to Java `List<T>` objects. The only variation to this pattern is when a message part is mapped directly to an instance of an XML Schema list type.

Defining list types in XML Schema

XML Schema list types are simple types and as such are defined using a `simpleType` element. The most common syntax used to define a list type is shown in Example 64 on page 131.

Example 64. Syntax for XML Schema List Types

```
<simpleType name="listType">
  <list itemType="atomicType">
    <facet value="value" />
    <facet value="value" />
    ...
  </list>
</simpleType>
```

The value given for *`atomicType`* defines the type of the elements in the list. It can only be one of the built in XML Schema atomic types, like xsd:int or xsd:string, or a user-defined simple type that is not a list.

In addition to defining the type of elements listed in the list type, you can also use facets to further constrain the properties of the list type. Table 14 on page 131 shows the facets used by list types.

Table 14. List Type Facets

Facet	Effect
`length`	Defines the number of elements in an instance of the list type.

Facet	Effect
`minLength`	Defines the minimum number of elements allowed in an instance of the list type.
`maxLength`	Defines the maximum number of elements allowed in an instance of the list type.
`enumeration`	Defines the allowable values for elements in an instance of the list type.
`pattern`	Defines the lexical form of the elements in an instance of the list type. Patterns are defined using regular expressions.

For example, the definition for the `simpleList` element shown in Example 63 on page 131, is shown in Example 65 on page 132.

Example 65. Definition of a List Type

```
<simpleType name="primeListType">
  <list itemType="int"/>
</simpleType>
<element name="primeList" type="primeListType"/>
```

In addition to the syntax shown in Example 64 on page 131 you can also define a list type using the less common syntax shown in Example 66 on page 132.

Example 66. Alternate Syntax for List Types

```
<simpleType name="listType">
  <list>
    <simpleType>
      <restriction base="atomicType">
        <facet value="value"/>
        <facet value="value"/>
        ...
      </restriction>
    </simpleType>
  </list>
  </simpleType>
```

Mapping list type elements to Java

When an element is defined as being of a list type, the list type is mapped to a collection property. A collection property is a Java `List<T>` object. The template class used by the `List<T>` is the wrapper class mapped from the list's base type. For example, the list type defined in Example 65 on page 132 would be mapped to a `List<Integer>`.

For more information on wrapper type mapping see Wrapper classes on page 123.

Mapping list type parameters to Java

When a message part is defined as being of a list type or is mapped to an element of a list type, the resulting method parameter is mapped to an array instead of a `List<T>` object. The base type of the array is the wrapper class of the list type's base class.

For example, the WSDL fragment in Example 67 on page 133 would result in the method signature in Example 68 on page 133.

Example 67. WSDL with a List Type Message Part

```
<definitions ...>
  ...
  <types ...>
    <schema ... >
      <simpleType name="primeListType">
        <list itemType="int"/>
      </simpleType>
      <element name="primeList" type="primeListType"/>
    </schemas>
  </types>
  <message name="numRequest">
    <part name="inputData" element="xsd1:primeList" />
  </message>
  <message name="numResponse">;
    <part name="outputData" type="xsd:int">
  ...
  <portType name="numberService">
    <operation name="primeProcessor">
      <input name="numRequest" message="tns:numRequest" />
      <output name="numResponse" message="tns:numResponse" />
    </operation>
    ...
  </portType>
  ...
</definitions>
```

Example 68. Java Method with a List Type Parameter

```
public interface NumberService {

    @XmlList
    @WebResult(name = "outputData", targetNamespace = "", partName = "outputData")
    @WebMethod
    public int primeProcessor(
        @WebParam(partName = "inputData", name = "primeList", targetNamespace = "...")
        java.lang.Integer[] inputData
    );
}
```

Unions

Overview

In XML Schema, a union is a construct that allows you to describe a type whose data can be one of any number of simple types. For example, you could define a type whose value could be either the integer `1` or the string `first`. Unions are mapped to Java `String`s.

Defining union types in XML Schema

XML Schema unions are defined using a `simpleType` element. They contain at least one `union` element that define the member types of the union. The member types of the union are the valid types of data that can be stored in an instance of the union. You define them using the `union` element's `memberTypes` attribute. The value of the `memberTypes` attribute contains a list of one or more defined simple type names. Example 69 on page 135 shows the definition of a union that can store either an integer or a string.

Example 69. Simple Union Type

```
<simpleType name="orderNumUnion">
  <union memberTypes="xsd:string xsd:int" />
</simpleType>
```

In addition to specifying named types to be a member type of a union, you can also define anonymous simple types to be a member type of a union. This is done by adding the anonymous type definition inside of the `union` element. Example 70 on page 135 shows an example of a union containing an anonymous member type restricting the possible values of a valid integer to 1 through 10.

Example 70. Union with an Anonymous Member Type

```
<simpleType name="restrictedOrderNumUnion">
  <union memberTypes="xsd:string">
    <simpleType>
      <restriction base="xsd:int">
        <minInclusive value="1" />
        <maxInclusive value="10" />
      </restriction>
    </simpleType>
  </union>
</simpleType>
```

Mapping to Java

XML Schema union types are mapped to Java `String` objects. By default, Artix ESB will not validate the contents of the generated object. To have Artix ESB validate the contents you will need to configure the runtime to use schema validation as described in Enforcing facets on page 127.

Simple Type Substitution

Overview

XML allows for simple type substitution between compatible types using the `xsi:type` attribute. The default mapping of simple types to Java primitive types, however, does not fully support simple type substitution. The runtime can handle basic simple type substitution, but information is lost. The code generators can be customized to generate Java classes that will facilitate lossless simple type substitution.

Default mapping and marshaling

The default mapping of simple types to Java primitive types presents problems for supporting simple type substitution. Java primitive types do not support any type of type substitution. The Java virtual machine will balk if an attempt is made to pass a short into a variable that expects an int.

To get around the limitations imposed by the Java type system, Artix ESB will allow for simple type substitution when the value of the element's `xsi:type` attribute meets one of the following conditions:

- It specifies a primitive type that is compatible with the element's schema type.
- It specifies a type that derives by restriction from the element’s schema type.
- It specifies a complex type that derives by extension from element’s schema type.

When the runtime does the type substitution it does not retain any knowledge of the type specified in the element's `xsi:type` attribute. If the type substitution was from a complex type to a simple type, only the value directly related to the simple type is preserved. Any other elements and attributes added by extension are lost.

Supporting lossless type substitution

You can customize the generation of simple types to facilitate lossless support of simple type substitution in two ways:

- Set the `globalBindings` customization element's `mapSimpleTypeDef` to `true`.

  This instructs the code generator to create Java value classes for all named simple types defined in the global scope.

For more information see Generating Java Classes for Simple Types on page 219.

- Add a `javaType` element to the `globalBindings` customization element

  This instructs the code generators to map all instances of an XML Schema primitive type to s specific class of object.

  For more information see Specifying the Java Class of an XML Schema Primitive on page 211.

- Add a `baseType` customization element to the specific element's you want to customize.

  The `baseType` customization element allows you to tell the code generator what type to map a property. To ensure the best compatibility for simple type substitution, you should use `java.lang.Object` as the base type.

  For more information see Specifying the Base Type of an Element or an Attribute on page 229.

Using Complex Types

Complex types can contain multiple elements and have attributes. They are mapped into Java classes that can hold the data represented by the type definition. Typically, the mapping is into a bean with a set of properties representing the elements and attributes of the content model..

Basic Complex Type Mapping

Overview

XML Schema complex types define constructs containing richer information than a simple type. The most simple complex types define an empty element with an attribute. More intricate complex types are made up of a collection of elements.

By default, an XML Schema complex type is mapped to a Java class with a member variable to represent each element and attribute listed in the XML Schema definition. The class will have setters and getters for each member variable.

Defining in XML Schema

XML Schema complex types are defined using the `complexType` element. The `complexType` element wraps the rest of elements used to define the structure of the data. It can appear either as the parent element of a named type definition or as the child of an `element` element anonymously defining the structure of the information stored in the element. When the `complexType` element is used to define a named type, it requires the use of the `name` attribute. The `name` attribute specifies a unique identifier for referencing the type.

Complex type definitions that contain one or more elements will have one of the child elements described in Table 15 on page 140. These elements determine how the specified elements will appear in an instance of the type.

Table 15. Elements for Defining How Elements Appear in a Complex Type

Element	Description
`all`	All of the elements defined as part of the complex type must appear in an instance of the type. However, they can appear in any order.
`choice`	Only one of the elements defined as part of the complex type can appear in an instance of the type.
`sequence`	All of the elements defined as part of the complex type must appear in an instance of the type. They must also appear in the order specified in the type definition.

Note

If a complex type definition only uses attributes, you do not need one of the elements described in Table 15 on page 140.

Once you have chosen how the elements will appear, you define the elements by adding one or more `element` element children to the definition.

Example 71 on page 141 shows a complex type definition in XML Schema.

Example 71. XML Schema Complex Type

```
<complexType name="sequence">
  <sequence>
    <element name="name" type="xsd:string" />
    <element name="street" type="xsd:short" />
    <element name="city" type="xsd:string" />
    <element name="state" type="xsd:string" />
    <element name="zipCode" type="xsd:string" />
  </sequence>
</complexType>
```

Mapping to Java

XML Schema complex types are mapped to Java classes. Each element in the complex type definition is mapped to a member variable in the Java class. Getter and setter methods are also generated for each element in the complex type.

All generated Java classes are decorated with the `@XmlType` annotation. If the mapping is for a named complex type, the annotations name is set to the value of the `complexType` element's `name` attribute. If the complex type is defined as part of an element definition, the value of the `@XmlType` annotation's name property is the value of the `element` element's `name` attribute.

Note

As described in Java mapping of elements with an in-line type on page 119, the generated class will be decorated with the `@XmlRootElement` annotation if it is generated for a complex type defined as part of an element definition.

To provide the runtime with guidelines about how the elements of the XML Schema complex type should be handled, the code generators alter the annotations used to decorate the class and its member variables.

all complex type
: All complex types are defined using the `all` element. They are annotated as follows:

  - The `@XmlType` annotation's propOrder property is empty.
  - Each element is decorated with the `@XmlElement` annotation.
  - The `@XmlElement` annotation's required property is set to `true`.

  Example 72 on page 142 shows the mapping for an all complex type with two elements.

Example 72. Mapping of an All Complex Type

```
@XmlType(name = "all", propOrder = {

})
public class All {
    @XmlElement(required = true)
    protected BigDecimal amount;
    @XmlElement(required = true)
    protected String type;

    public BigDecimal getAmount() {
        return amount;
    }

    public void setAmount(BigDecimal value) {
        this.amount = value;
    }

    public String getType() {
        return type;
    }

    public void setType(String value) {
        this.type = value;
    }
}
```

choice complex type

Choice complex types are defined using the `choice` element. They are annotated as follows:

- The `@XmlType` annotation's propOrder property lists the names of the elements in the order they appear in the XML Schema definition.
- None of the member variables are annotated.

Example 73 on page 143 shows the mapping for a choice complex type with two elements.

Example 73. Mapping of a Choice Complex Type

```
@XmlType(name = "choice", propOrder = {
    "address",
    "floater"
})
public class Choice {

    protected Sequence address;
    protected Float floater;

    public Sequence getAddress() {
        return address;
    }

    public void setAddress(Sequence value) {
        this.address = value;
    }

    public Float getFloater() {
        return floater;
    }

    public void setFloater(Float value) {
        this.floater = value;
    }

}
```

sequence complex type

A sequence complex type is defined using the `sequence` element. It is annotated as follows:

- The @XmlType annotation's propOrder property lists the names of the elements in the order they appear in the XML Schema definition.
- Each element is decorated with the @XmlElement annotation.
- The @XmlElement annotation's required property is set to true.

Example 74 on page 144 shows the mapping for the complex type defined in Example 71 on page 141.

Example 74. Mapping of a Sequence Complex Type

```
@XmlType(name = "sequence", propOrder = {
    "name",
    "street",
    "city",
    "state",
    "zipCode"
})
public class Sequence {

    @XmlElement(required = true)
    protected String name;
    protected short street;
    @XmlElement(required = true)
    protected String city;
    @XmlElement(required = true)
    protected String state;
    @XmlElement(required = true)
    protected String zipCode;

    public String getName() {
        return name;
    }

    public void setName(String value) {
        this.name = value;
    }

    public short getStreet() {
        return street;
    }

    public void setStreet(short value) {
        this.street = value;
    }

    public String getCity() {
        return city;
    }

    public void setCity(String value) {
        this.city = value;
    }

    public String getState() {
        return state;
    }

    public void setState(String value) {
        this.state = value;
    }

    public String getZipCode() {
        return zipCode;
    }

    public void setZipCode(String value) {
        this.zipCode = value;
    }
}
```

Attributes

Overview

Artix ESB supports the use of `attribute` elements and `attributeGroup` elements within the scope of a `complexType` element. When defining structures for an XML document attribute declarations provide a means of adding information to be specified within the tag, not the value that the tag contains. For example, when describing the XML element <value currency="euro">410<\value> in XML Schema currency would be described using an `attribute` element as shown in Example 75 on page 147.

The `attributeGroup` element allows you to define a group of reusable attributes that can be referenced by all complex types defined by the schema. For example, if you are defining a series of elements that all use the attributes `category` and `pubDate`, you could define an attribute group with these attributes and reference them in all the elements that use them. This is shown in Example 77 on page 148.

When describing data types for use in developing application logic, attributes whose `use` attribute is set to either `optional` or `required` are treated as elements of a structure. For each attribute declaration contained within a complex type description, an element is generated in the class for the attribute along with the appropriate getter and setter methods.

Defining an attribute in XML Schema

An XML Schema `attribute` element has one required attribute, `name`, that is used to identify the attribute. It also has four optional attributes that are described in Table 16 on page 146.

Table 16. Attributes Used to Define Attributes in XML Schema

Attribute	Description
`use`	Specifies if the attribute is required. Valid values are `required`, `optional`, or `prohibited`. `optional` is the default value.
`type`	Specifies the type of value the attribute can take. If it is not used the schema type of the attribute must be defined in-line.
`default`	Specifies a default value to use for the attribute. It is only used when the `attribute` element's `use` attribute is set to `optional`.

Attribute	Description
fixed	Specifies a fixed value to use for the attribute. It is only used when the attribute element's use attribute is set to optional.

Example 75 on page 147 shows an attribute element defining an attribute, currency, whose value is a string.

Example 75. XML Schema Defining and Attribute

```
<element name="value">
  <complexType>
    <xsd:simpleContent>
      <xsd:extension base="xsd:integer">
        <xsd:attribute name="currency" type="xsd:string"
                       use="required"/>
      </xsd:extension>
    </xsd:simpleContent>
  </xsd:complexType>
</xsd:element>
```

If the type attribute is omitted from the attribute element, the format of the data must be described in-line. Example 76 on page 147 shows an attribute element for an attribute, category, that can take the values autobiography, non-fiction, or fiction.

Example 76. Attribute with an In-Line Data Description

```
<attribute name="category" use="required">
  <simpleType>
    <restriction base="xsd:string">
      <enumeration value="autobiography"/>
      <enumeration value="non-fiction"/>
      <enumeration value="fiction"/>
    </restriction>
  </simpleType>
</attribute>
```

Using an attribute group in XML Schema

Using an attribute group in a complex type definition is a two step process:

1. Define the attribute group.

   An attribute group is defined using an attributeGroup element with a number of attribute child elements. The attributeGroup requires a name attribute that defines the string used to refer to the attribute group. The attribute elements define the members of the attribute group and are specified as shown in Defining an attribute in XML Schema on page 146. Example 77 on page 148 shows the description of the attribute group catalogIndecies. The attribute group has two members: category is optional. pubDate is required.

Example 77. Attribute Group Definition

```
<attributeGroup name="catalogIndices">
  <attribute name="category" type="catagoryType" />
  <attribute name="pubDate" type="dateTime"
             use="required" />
</attributeGroup>
```

2. Use the attribute group in the definition of a complex type.

   You use attribute groups in complex type definitions by using the attributeGroup element with the ref attribute. The value of the ref attribute is the name given the attribute group that you want to use as part of the type definition. For example if you wanted to use the attribute group catalogIndecies in the complex type dvdType, you would use <attributeGroup ref="catalogIndecies" /> as shown in Example 78 on page 148.

Example 78. Complex Type with an Attribute Group

```
<complexType name="dvdType">
  <sequence>
    <element name="title" type="xsd:string" />
    <element name="director" type="xsd:string" />
    <element name="numCopies" type="xsd:int" />
  </sequence>
  <attributeGroup ref="catalogIndices" />
</complexType>
```

Mapping attributes to Java

Attributes are mapped to Java similarly to member elements. Required attributes and optional attributes are mapped to member variables in the generated Java class. The member variables are decorated with the @XmlAttribute annotation. If the attribute is required, the @XmlAttribute annotation's required property will be set to true.

The complex type defined in Example 79 on page 149 will be mapped to the Java class shown in Example 80 on page 149.

Example 79. techDoc Description

```
<complexType name="techDoc">
  <all>
    <element name="product" type="xsd:string" />
    <element name="version" type="xsd:short" />
  </all>
  <attribute name="usefullness" type="xsd:float"
             use="optional" default="0.01" />
</complexType>
```

Example 80. techDoc Java Class

```
@XmlType(name = "techDoc", propOrder = {

})
public class TechDoc {

    @XmlElement(required = true)
    protected String product;
    protected short version;
    @XmlAttribute
    protected Float usefullness;

    public String getProduct() {
        return product;
    }

    public void setProduct(String value) {
        this.product = value;
    }

    public short getVersion() {
        return version;
    }

    public void setVersion(short value) {
        this.version = value;
    }

    public float getUsefullness() {
        if (usefullness == null) {
            return  0.01F;
        } else {
            return usefullness;
        }
    }

    public void setUsefullness(Float value) {
        this.usefullness = value;
    }
}
```

As shown in Example 80 on page 149, the `default` attribute and the `fixed` attribute instruct the code generators to add code to the getter method generated for the attribute. This additional code ensures that the specified value is returned if no value is set.

Important

The `fixed` attribute is treated the same as the `default` attribute. If you want the `fixed` attribute to be treated as a Java constant you can use the customization described in Customizing Fixed Value Attribute Mapping on page 226.

Mapping attribute Groups to Java

Attribute groups are mapped into Java as if the members of the group were explicitly used in the type definition. If your attribute group has three members, and it is used in a complex type, the generated class for that type will include a member variable, along with the getter and setter methods, for each member of the attribute group. For example, the complex type defined in Example 78 on page 148, Artix ESB would generate a class that contained the member variables `category` and `pubDate` to support the members of the attribute group used in the definition as shown in Example 81 on page 150.

Example 81. dvdType Java Class

```
@XmlType(name = "dvdType", propOrder = {
    "title",
    "director",
    "numCopies"
})
public class DvdType {

    @XmlElement(required = true)
    protected String title;
    @XmlElement(required = true)
    protected String director;
    protected int numCopies;
    @XmlAttribute
    protected CatagoryType category;
    @XmlAttribute(required = true)
    @XmlSchemaType(name = "dateTime")
    protected XMLGregorianCalendar pubDate;

    public String getTitle() {
        return title;
    }

    public void setTitle(String value) {
        this.title = value;
    }

    public String getDirector() {
        return director;
    }

    public void setDirector(String value) {
        this.director = value;
    }

    public int getNumCopies() {
        return numCopies;
    }

    public void setNumCopies(int value) {
        this.numCopies = value;
    }

    public CatagoryType getCatagory() {
        return catagory;
    }

    public void setCatagory(CatagoryType value) {
        this.catagory = value;
    }

    public XMLGregorianCalendar getPubDate() {
        return pubDate;
    }

    public void setPubDate(XMLGregorianCalendar value) {
        this.pubDate = value;
    }

}
```

Deriving Complex Types from Simple Types

Overview

Artix ESB supports derivation of a complex type from a simple type. A simple type has, by definition, neither sub-elements nor attributes. Hence, one of the main reasons for deriving a complex type from a simple type is to add attributes to the simple type.

There are two ways of deriving a complex type from a simple type:

- by extension
- by restriction

Derivation by extension

Example 82 on page 152 shows an example of a complex type, internationalPrice, derived by extension from the xsd:decimal primitive type to include a currency attribute.

Example 82. Deriving a Complex Type from a Simple Type by Extension

```
<complexType name="internationalPrice">
    <simpleContent>
        <extension base="xsd:decimal">
            <attribute name="currency" type="xsd:string"/>
        </extension>
    </simpleContent>
    </complexType>
```

The `simpleContent` element indicates that the new type does not contain any sub-elements. The `extension` element specifies that the new type extends xsd:decimal.

Derivation by restriction

Example 83 on page 152 shows an example of a complex type, idType, that is derived by restriction from xsd:string. The defined type restricts the possible values of xsd:stringto values that are ten characters in length. It also adds an attribute to the type.

Example 83. Deriving a Complex Type from a Simple Type by Restriction

```
<complexType name="idType">
  <simpleContent>
    <restriction base="xsd:string">
     <length value="10" />
     <attribute name="expires" type="xsd:dateTime" />
    </restriction>
  </simpleContent>
</complexType>
```

As is Example 82 on page 152 the `simpleContent` element signals that the new type does not contain any children. This example uses a `restriction` element to constrain the possible values used in the new type. The `attribute` element adds the element to the new type.

Mapping to Java

A complex type derived from a simple type is mapped to a Java class that is decorated with the `@XmlType` annotation. The generated class will contain a member variable, `value`, of the simple type from which the complex type is derived. The member variable will be decorated with the `@XmlValue` annotation. The class will also have a `getValue()` method and a `setValue()` method. In addition, the generated class will have a member variable, and the associated getter and setter methods, for each attribute that extends the simple type.

Example 84 on page 153 shows the Java class generated for the idType type defined in Example 83 on page 152.

Example 84. idType Java Class

```
@XmlType(name = "idType", propOrder = {
    "value"
})
public class IdType {

    @XmlValue
    protected String value;
    @XmlAttribute
    @XmlSchemaType(name = "dateTime")
    protected XMLGregorianCalendar expires;

    /**
     * Gets the value of the value property.
     *
     * @return
     *     possible object is
     *     {@link String }
     *
     */
    public String getValue() {
        return value;
    }

    /**
     * Sets the value of the value property.
     *
     * @param value
     *     allowed object is
     *     {@link String }
     *
     */
    public void setValue(String value) {
        this.value = value;
    }

    /**
     * Gets the value of the expires property.
     *
     * @return
     *     possible object is
     *     {@link XMLGregorianCalendar }
     *
     */
    public XMLGregorianCalendar getExpires() {
        return expires;
    }

    /**
     * Sets the value of the expires property.
     *
     * @param value
     *     allowed object is
     *     {@link XMLGregorianCalendar }
     *
     */
    public void setExpires(XMLGregorianCalendar value) {
        this.expires = value;
    }

}
```

Deriving Complex Types from Complex Types

Overview

Using XML Schema, you can derive new complex types by extending or restricting other complex types using the `complexContent` element. When generating the Java class to represent the derived complex type, Artix ESB extends the base type's class. In this way, the generated Java code preserves the inheritance hierarchy intended in the XML Schema.

Schema syntax

You derive complex types from other complex types by using the `complexContent` element and either the `extension` element or the `restriction` element. The `complexContent` element specifies that the included data description includes more than one field. The `extension` element and the `restriction` element, which are children of the `complexContent` element, specifies the base type being modified to create the new type. The base type is specified by the `base` attribute.

Extending a complex type

You extend a complex type using the `extension` element to define the additional elements and attributes that make up the new type. All elements that are allowed in a complex type description are allowable as part of the new type's definition. For example, you could add an anonymous enumeration to the new type, or you could use the `choice` element to specify that only one of the new fields is to be valid at a time.

Example 85 on page 155 shows an XML Schema fragment that defines two complex types, widgetOrderInfo and widgetOrderBillInfo. widgetOrderBillInfo is derived by extending widgetOrderInfo to include two new elements: `orderNumber` and `amtDue`.

Example 85. Deriving a Complex Type by Extension

```
<complexType name="widgetOrderInfo">
  <sequence>
    <element name="amount" type="xsd:int"/>
    <element name="order_date" type="xsd:dateTime"/>
    <element name="type" type="xsd1:widgetSize"/>
    <element name="shippingAddress" type="xsd1:Address"/>
  </sequence>
  <attribute name="rush" type="xsd:boolean" use="optional" />
</complexType>
<complexType name="widgetOrderBillInfo">
```

```
  <complexContent>
    <extension base="xsd1:widgetOrderInfo">
      <sequence>
        <element name="amtDue" type="xsd:decimal"/>
        <element name="orderNumber" type="xsd:string"/>
      </sequence>
      <attribute name="paid" type="xsd:boolean"
                 default="false" />
    </extension>
  </complexContent>
</complexType>
```

Restricting a complex type

You restrict a complex type using the `restriction` element to limit the possible values of the base type's elements or attributes. When restricting a complex type you must list all of the elements and attributes of the base type. For each element you can add restrictive attributes to the definition. For example, you could add a `maxOccurs` attribute to an element to limit the number of times it can occur. You could also use the `fixed` attribute to force one or more of the elements to have predetermined values.

Example 86 on page 156 shows an example of defining a complex type by restricting another complex type. The restricted type, wallawallaAddress, can only be used for addresses in Walla Walla, Washington because the values for city, state, and zipCode have been fixed.

Example 86. Defining a Complex Type by Restriction

```
<complexType name="Address">
  <sequence>
    <element name="name" type="xsd:string"/>
    <element name="street" type="xsd:short" maxOccurs="3"/>
    <element name="city" type="xsd:string"/>
    <element name="state" type="xsd:string"/>
    <element name="zipCode" type="xsd:string"/>
  </sequence>
</complexType>
<complexType name="wallawallaAddress">
  <complexContent>
    <restriction base="xsd1:Address">
      <sequence>
        <element name="name" type="xsd:string"/>
        <element name="street" type="xsd:short"
                 maxOccurs="3"/>
        <element name="city" type="xsd:string"
                 fixed="WallaWalla"/>
        <element name="state" type="xsd:string"
                 fixed="WA" />
        <element name="zipCode" type="xsd:string"
                 fixed="99362" />
      </sequence>
    </restriction>
  </complexContent>
</complexType>
```

Mapping to Java

As it does with all complex types, Artix ESB generates a class to represent complex types derived from another complex type. The Java class generated for the derived complex type extends the Java class generated to support the base complex type.

Important

To ensure that the runtime can find all of the classes needed to handle the derived types you may need to configure the runtime to load additional classes. This is described in Adding Classes to the Runtime Marshaller on page 110.

When the new complex type is derived by extension, the generated class will include member variables for all of the added elements and attributes. The new member variables will be generated according to the same mappings as all other elements.

When the new complex type is derived by restriction, the generated class will have no new member variables. The generated class will simply be a shell that does not provide any additional functionality. It is entirely up to you to ensure that the restrictions defined in the XML Schema are enforced.

For example, the schema in Example 85 on page 155 would result in the generation of two Java classes: `WidgetOrderInfo` and `WidgetBillOrderInfo`. `WidgetOrderBillInfo` would extend `WidgetOrderInfo` because widgetOrderBillInfo is derived by extension from widgetOrderInfo. Example 87 on page 157 shows the generated class for widgetOrderBillInfo.

Example 87. WidgetOrderBillInfo

```
@XmlType(name = "widgetOrderBillInfo", propOrder = {
    "amtDue",
    "orderNumber"
})
```

```
public class WidgetOrderBillInfo
    extends WidgetOrderInfo
{
    @XmlElement(required = true)
    protected BigDecimal amtDue;
    @XmlElement(required = true)
    protected String orderNumber;
    @XmlAttribute
    protected Boolean paid;

    public BigDecimal getAmtDue() {
        return amtDue;
    }

    public void setAmtDue(BigDecimal value) {
        this.amtDue = value;
    }

    public String getOrderNumber() {
        return orderNumber;
    }

    public void setOrderNumber(String value) {
        this.orderNumber = value;
    }

    public boolean isPaid() {
        if (paid == null) {
            return false;
        } else {
            return paid;
        }
    }

    public void setPaid(Boolean value) {
        this.paid = value;
    }
}
```

Occurrence Constraints

XML Schema allows you to specify the occurrence constraints on four of the XML Schema elements that make up a complex type definition:

- `all`
- `choice`
- `element`
- `sequence`

Occurrence Constraints on the All Element

XML Schema

Complex types defined with the `all` element do not allow for multiple occurrences of the structure defined by the `all` element. You can, however, make the structure defined by the `all` element optional by setting its `minOccurs` attribute to `0`.

Mapping to Java

Setting the `all` element's `minOccurs` attribute to `0` has no effect on the generated Java class.

Occurrence Constraints on the Choice Element

Overview

By default, the results of a `choice` element can only appear once in an instance of a complex type. You can change the number of times the element chosen to represent the structure defined by a `choice` element is allowed to appear using its `minOccurs` attribute and its `mxOccurs` attribute. Using these attributes you can specify that the choice type can occur zero to an unlimited number of times in an instance of a complex type. The element chosen for the choice type does not need to be the same for each occurrence of the type.

Using in XML Schema

The `minOccurs` attribute specifies the minimum number of times the choice type must appear. Its value can be any positive integer. Setting the `minOccurs` attribute to `0` specifies that the choice type does not need to appear inside an instance of the complex type.

The `maxOccurs` attribute specifies the maximum number of times the choice type can appear. Its value can be any non-zero, positive integer or `unbounded`. Setting the `maxOccurs` attribute to `unbounded` specifies that the choice type can appear an infinite number of times.

Example 88 on page 161 shows the definition of a choice type, ClubEvent, with choice occurrence constraints. The choice type overall can be repeated 0 to unbounded times.

Example 88. Choice Occurrence Constraints

```
<complexType name="ClubEvent">
  <choice minOccurs="0" maxOccurs="unbounded">
    <element name="MemberName" type="xsd:string"/>
    <element name="GuestName" type="xsd:string"/>
  </choice>
</complexType>
```

Mapping to Java

Unlike single instance choice structures, XML Schema choice structures that can occur multiple times are mapped to a Java class with a single member variable. This single member variable is a `List<T>` object that holds all of the data for the multiple occurrences of the sequence. For example, if the sequence defined in Example 88 on page 161 occurred two times the list would have 2 items.

The name of the Java class' member variable is derived by concatenating the names of the member elements. The element names are separated by `Or` and the first letter of the variable name is converted to lower case. For example, the member variable generated from Example 88 on page 161 would be named `memberNameOrGuestName`.

The type of object stored in the list depends on the relationship between the types of the member elements.

- If the member elements are of the same type the generated list will contain `JAXBElement<T>` objects. The base type of the `JAXBElement<T>` objects is determined by the normal mapping of the member elements' type.
- If the member elements are of different types and their Java representations implement a common interface, the list will contains objects of the common interface.
- If the member elements are of different types and their Java representations extend a common base class, the list will contains objects of the common base class.
- If none of the other conditions are met, the list will contain `Object` objects.

The generated Java class will only have a getter method for the member variable. The getter method returns a reference to the live list. Any modifications made to the returned list will effect the actual object.

The Java class will be decorated with the `@XmlType` annotation. The annotation's name property will be set to the value of the `name` attribute from the parent element of the XML Schema definition. The annotation's propOrder property will contain the single member variable representing the elements in the sequence.

The member variable representing the elements in the choice structure are decorated with the `@XmlElements` annotation. The `@XmlElements` annotation contains a comma separated list of `@XmlElement` annotations. The list will have one `@XmlElement` annotation for each member element defined in the XML Schema definition of type. The `@XmlElement` annotations in the list will have their name property set to the value of the XML Schema `element`

element's `name` attribute and their type property set to the Java class resulting from the mapping of the XML Schema `element` element's type.

Example 89 on page 163 shows the Java mapping for the XML Schema choice structure defined in Example 88 on page 161.

Example 89. Java Representation of Choice Structure with an Occurrence Constraint

```
@XmlType(name = "ClubEvent", propOrder = {
    "memberNameOrGuestName"
})
public class ClubEvent {

    @XmlElementRefs({
        @XmlElementRef(name = "GuestName", type = JAXBElement.class),
        @XmlElementRef(name = "MemberName", type = JAXBElement.class)
    })
    protected List<JAXBElement<String>> memberNameOrGuestName;

    public List<JAXBElement<String>> getMemberNameOrGuestName() {
        if (memberNameOrGuestName == null) {
            memberNameOrGuestName = new ArrayList<JAXBElement<String>>();
        }
        return this.memberNameOrGuestName;
    }

}
```

minOccurs set to 0

If only the `minOccurs` element is specified and its value is `0`, the code generators will generate the Java class as if the `minOccurs` attribute were not set.

Occurrence Constraints on Elements

Overview

You can specify how many times a specific element in a complex type appears using the `element` element's `minOccurs` attribute and `maxOccurs` attribute. The default value for both attributes is `1`.

minOccurs set to 0

When you set one of the complex type's member element's `minOccurs` attribute to `0`, the `@XmlElement` annotation decorating the corresponding Java member variable is changed. Instead of having its required property set to `true`, the `@XmlElement` annotation's required property is set to `false`.

minOccurs set to a value greater than 1

In XML Schema you can specify that an element must occur more than once in an instance of the type by setting the `element` element's `minOccurs` attribute to a value greater than one. However, the generated Java class will not support the XML Schema constraint. Artix ESB generates the supporting Java member variable as if the `minOccurs` attribute were not set.

Elements with maxOccurs set

When you want a member element to appear multiple times in an instance of a complex type, you set the element's `maxOccurs` attribute to a value greater than 1. You can set the `maxOccurs` attribute's value to `unbounded` to specify that the member element can appear an unlimited number of times.

The code generators map a member element with the `maxOccurs` attribute set to a value greater than 1 to Java member variable that is an `List<T>` object. The base class of the list is determined by mapping the element's type to Java. For XML Schema primitive types, the wrapper classes are used as described in Wrapper classes on page 123. For example, if the member element is of type xsd:int the generated member variable would be a `List<Integer>` object.

Occurrence Constraints on Sequences

Overview

By default, the contents of a `sequence` element can only appear once in an instance of a complex type. You can change the number of times the sequence of elements defined by a `sequence` element is allowed to appear using its `minOccurs` attribute and its `maxOccurs` attribute. Using these attributes you can specify that the sequence type can occur zero to an unlimited number of times in an instance of a complex type.

Using XML Schema

The `minOccurs` attribute specifies the minimum number of times the sequence must occur in an instance of the defined complex type. Its value can be any positive integer. Setting the `minOccurs` attribute to `0` specifies that the sequence does not need to appear inside an instance of the complex type.

The `maxOccurs` attribute specifies the upper limit for how many times the sequence can occur in an instance of the defined complex type. Its value can be any non-zero, positive integer or `unbounded`. Setting the `maxOccurs` attribute to `unbounded` specifies that the sequence can appear an infinite number of times.

Example 90 on page 165 shows the definition of a sequence type, CultureInfo, with sequence occurrence constraints. The sequence can be repeated 0 to 2 times.

Example 90. Sequence with Occurrence Constraints

```
<complexType name="CultureInfo">
  <sequence minOccurs="0" maxOccurs="2">
    <element name="Name" type="string"/>
    <element name="Lcid" type="int"/>
  </sequence>
</complexType>
```

Mapping to Java

Unlike single instance sequences, XML Schema sequences that can occur multiple times are mapped to a Java class with a single member variable. This single member variable is a `List<T>` object that holds all of the data for the multiple occurrences of the sequence. For example, if the sequence defined in Example 90 on page 165 occurred two times the list would have 4 items.

The name of the Java class' member variable is derived by concatenating the names of the member elements. The element names are separated by `And` and the first letter of the variable name is converted to lower case. For example, the member variable generated from Example 90 on page 165 would be named `nameAndLcid`.

The type of object stored in the list depends on the relationship between the types of the member elements.

- If the member elements are of the same type the generated list will contain `JAXBElement<T>` objects. The base type of the `JAXBElement<T>` objects is determined by the normal mapping of the member elements' type.
- If the member elements are of different types and their Java representations implement a common interface, the list will contains objects of the common interface.
- If the member elements are of different types and their Java representations extend a common base class, the list will contains objects of the common base class.
- If none of the other conditions are met, the list will contain `Object` objects.

The generated Java class will only have a getter method for the member variable. The getter method returns a reference to the live list. Any modifications made to the returned list will effect the actual object.

The Java class will be decorated with the `@XmlType` annotation. The annotation's name property will be set to the value of the `name` attribute from the parent element of the XML Schema definition. The annotation's propOrder property will contain the single member variable representing the elements in the sequence.

The member variable representing the elements in the sequence are decorated with the `@XmlElements` annotation. The `@XmlElements` annotation contains a comma separated list of `@XmlElement` annotations. The list will have one `@XmlElement` annotation for each member element defined in the XML Schema definition of type. The `@XmlElement` annotations in the list will have their name property set to the value of the XML Schema `element` element's name attribute and their type property set to the Java class resulting from the mapping of the XML Schema element element's type.

Example 91 on page 167 shows the Java mapping for the XML Schema sequence defined in Example 90 on page 165.

Example 91. Java Representation of Sequence with an Occurrence Constraint

```
@XmlType(name = "CultureInfo", propOrder = {
    "nameAndLcid"
})
public class CultureInfo {

    @XmlElements({
        @XmlElement(name = "Name", type = String.class),
        @XmlElement(name = "Lcid", type = Integer.class)
    })
    protected List<Serializable> nameAndLcid;

    public List<Serializable> getNameAndLcid() {
        if (nameAndLcid == null) {
            nameAndLcid = new ArrayList<Serializable>();
        }
        return this.nameAndLcid;
    }

}
```

minOccurs set to 0

If only the minOccurs element is specified and its value is 0, the code generators will generate the Java class as if the minOccurs attribute were not set.

Using Model Groups

Overview

XML Schema model groups are a convenient shortcut that enables you to reference a group of elements from a user-defined complex type.For example, you could define a group of elements that are common to several types in your application and then reference the group repeatedly. Model groups are defined using the `group` element and are similar to complex type definitions.

The mapping of model groups to Java is also similar to the mapping for complex types.

Defining a model group in XML Schema

You define a model group in XML Schema using the `group` element with the `name` attribute. The value of the `name` attribute is a string that is used to refer to the group throughout the schema. The `group` element, like the `complexType` element, can have either the `sequence` element, the `all` element, or the `choice` element as its immediate child.

Inside the child element, you define the members of the group using `element` elements. For each member of the group, you specify one `element` element. Group members can use any of the standard attributes for the `element` element including `minOccurs` and `maxOccurs`. So, if your group has three elements and one of them can occur up to three times, you would define a group with three `element` elements, one of which would use maxOccurs="3". Example 92 on page 168 shows a model group with three elements.

Example 92. XML Schema Model Group

```
<group name="passenger">
  <sequence>
    <element name="name" type="xsd:string" />
    <element name="clubNum" type="xsd:long" />
    <element name="seatPref" type="xsd:string"
             maxOccurs="3" />
  </sequence>
</group>
```

Using a model group in a type definition

Once a model group has been defined, you can use it as part of a complex type definition. To use a model group in a complex type definition, you use the `group` element with the `ref` attribute. The value of the `ref` attribute is the name given to the group when it was defined. For example, to use the group defined in Example 92 on page 168 you would use <group ref="tns:passenger" /> as shown in Example 93 on page 169.

Example 93. Complex Type with a Model Group

```
<complexType name="reservation">
  <sequence>
    <group ref="tns:passenger" />
    <element name="origin" type="xsd:string" />
    <element name="destination" type="xsd:string" />
    <element name="fltNum" type="xsd:long" />
  </sequence>
</complexType>
```

When a model group is used in a type definition, the group becomes a member of the type. So an instance of reservation would have four member elements. The first of which would be `passenger` and it would contain the member elements defined by the group Example 92 on page 168. An example of an instance of reservation as shown in Example 94 on page 169.

Example 94. Instance of a Type with a Model Group

```
<reservation>
  <passenger>
    <name>A. Smart</name>
    <clubNum>99</clubNum>
    <seatPref>isle1</seatPref>
  </passenger>
  <origin>LAX</origin>
  <destination>FRA</destination>
  <fltNum>34567</fltNum>
</reservation>
```

Mapping to Java

By default, a model group is only mapped into Java artifacts when it is included in a complex type definition. When generating code for a complex type that includes a model group, Artix ESB simply includes the member variables for the model group into the Java class generated for the type. The member variables representing the model group will be annotated based on the definitions of the model group.

Example 95 on page 170 shows the Java class generated for the complex type defined in Example 93 on page 169.

Example 95. Type with a Group

```
@XmlType(name = "reservation", propOrder = {
    "name",
    "clubNum",
    "seatPref",
    "origin",
    "destination",
    "fltNum"
})
public class Reservation {

    @XmlElement(required = true)
    protected String name;
    protected long clubNum;
    @XmlElement(required = true)
    protected List<String> seatPref;
    @XmlElement(required = true)
    protected String origin;
    @XmlElement(required = true)
    protected String destination;
    protected long fltNum;

    public String getName() {
        return name;
    }

    public void setName(String value) {
        this.name = value;
    }

    public long getClubNum() {
        return clubNum;
    }

    public void setClubNum(long value) {
        this.clubNum = value;
    }

    public List<String> getSeatPref() {
        if (seatPref == null) {
            seatPref = new ArrayList<String>();
        }
        return this.seatPref;
    }

    public String getOrigin() {
        return origin;
    }
```

```
public void setOrigin(String value) {
    this.origin = value;
}

public String getDestination() {
    return destination;
}

public void setDestination(String value) {
    this.destination = value;
}

public long getFltNum() {
    return fltNum;
}

public void setFltNum(long value) {
    this.fltNum = value;
}
```

Multiple occurrences

You can specify that the model group appears more than once by setting the `group` element's `maxOccurs` attribute to a value greater than one. To allow for multiple occurrences of the model group Artix ESB maps the model group to a `List<T>` object. The `List<T>` object is generated following the rules for the group's first child. If the group is defined using a `sequence` element see Occurrence Constraints on Sequences on page 165. If the group is defined using a `choice` element see Occurrence Constraints on the Choice Element on page 161.

Using Wild Card Types

There are instances when a schema author wants to defer binding elements or attributes to a defined type. For these cases, XML Schema provides three mechanisms for specifying wild card place holders. These are all mapped to Java in ways that preserve their XML Schema functionality.

Using Any Elements

Overview

The XML Schema `any` element is used to create a wildcard place holder in complex type definitions. When an XML element is instantiated for an XML Schema `any` element, it can be any valid XML element. The `any` element does not place any restrictions on either the content or the name of the instantiated XML element.

For example given the complex type definied in Example 96 on page 174 you could instantiate either of the XML elements shown in Example 97 on page 174.

Example 96. XML Schema Type Defined with an Any Element

```
<element name="FlyBoy">
  <complexType>
    <sequence>
      <any />
      <element name="rank" type="xsd:int" />
    </sequence>
  </complexType>
</element>
```

Example 97. XML Document with an Any Element

```
<FlyBoy>
  <learJet>CL-215</learJet>
  <rank>2</rank>
</element>
<FlyBoy>
  <viper>Mark II</viper>
  <rank>1</rank>
</element>
```

XML Schema `any` elements are mapped to either a Java `Object` object or a Java `org.w3c.dom.Element` object.

Specifying in XML Schema

The `any` element can be used when defining sequence complex types and choice complex types. In most cases, the `any` element is an empty element. It can, however, take an `annotation` element as a child.

Table 17 on page 175 describes the `any` element's attributes.

Table 17. Attributes of the XML Schema Any Element

Attribute	Description

`namespace`	Specifies the namespace of the elements that can be used to instantiate the element in an XML document. The valid values are:
	
	`##any`
	Specifies that elements from any namespace can be used. This is the default.
	
	`##other`
	Specifies that elements from any namespace *other than the parent element*'s *namespace* can be used.
	
	`##local`
	Specifies elements without a namespace must be used.
	
	`##targetNamespace`
	Specifies that elements from the parent element's namespace must be used.
	
	space delimited list of URIs, `##local`, and `##targetNamespace`
	Specifies that elements from any of the listed namespaces can be used.

`maxOccurs`	Specifies the maximum number of times an instance of the element can appear in the parent element. The default value is `1`. To specify that an instance of the element can appear an unlimited number of times, you can set the attribute's value to `unbounded`.
`minOccurs`	Specifies the minimum number of times an instance of the element can appear in the parent element. The default value is `1`.

`processContents`	Specifies how the element used to instantiate the any element should be validated. Valid values are:
	
	`strict`
	Specifies that the element must be validated against the proper schema. This is the default value.
	
	`lax`
	Specifies that the element should be validated against the proper schema. If it cannot be validated, no errors are thrown.
	
	`skip`
	Specifies that the element should not be validated.

Example 98 on page 176 shows a complex type defined with an `any` element

Example 98. Complex Type Defined with an Any Element

```
<complexType name="surprisePackage">
  <sequence>
    <any processContents="lax" />
    <element name="to" type="xsd:string" />
    <element name="from" type="xsd:string" />
  </sequence>
</complexType>
```

Mapping to Java

XML Schema `any` elements result in the creation of a Java property named `any`. The property has associated getter and setter methods. The type of the resulting property depends on the value of the element's `processContents` attribute. If the `any` element's `processContents` attribute is set `skip`, the element is mapped to a `org.w3c.dom.Element` object. For all other values of the `processContents` attribute an `any` element is mapped to a Java `Object` object.

The generated property is decorated with the `@XmlAnyElement` annotation. This annotation has an optional lax property that instructs the runtime what to do when marshaling the data. Its default value is `false` which instructs the runtime to automatically marshal the data into a `org.w3c.dom.Element` object. Setting lax to `true` instructs the runtime to attempt to marshal the data into JAXB types. When the `any` element's `processContents` attribute is set `skip`, the lax property is set to its default. For all other values of the `processContents` attribute, lax is set to `true`.

Example 99 on page 176 shows how the complex type defined in Example 98 on page 176 is mapped to a Java class.

Example 99. Java Class with an Any Element

```
public class SurprisePackage {

    @XmlAnyElement(lax = true)
    protected Object any;
    @XmlElement(required = true)
    protected String to;
    @XmlElement(required = true)
    protected String from;

    public Object getAny() {
        return any;
    }

    public void setAny(Object value) {
        this.any = value;
    }

    public String getTo() {
        return to;
    }

    public void setTo(String value) {
        this.to = value;
    }

    public String getFrom() {
        return from;
    }

    public void setFrom(String value) {
        this.from = value;
    }

}
```

Marshaling

If the Java property for an `any` element has its lax set to `false` or the property is not specified, the runtime will make no attempt to parse the XML data into JAXB objects. The data will always be stored in a DOM `Element` object.

If the Java property for an `any` element has its lax set to `true`, the runtime will attempt to marshal the XML data into appropriate JAXB objects. The runtime attempts to identify the proper JAXB classes using the following method:

1. It checks the element's tag of the XML element against the list of elements known to the runtime. If it finds a match, the runtime marshals the XML data into the proper JAXB class for the element.
2. It checks the XML element's `xsi:type` attribute. If it finds a match, the runtime marshals the XML element into the proper JAXB class for that type.

3. If it cannot find a match is marshals the XML data into a DOM `Element` object.

An application's runtime generally knows about all of the types generated from the schema's included in its contract. This includes the types defined in the contract's `wsdl:types` element, any data types added to the contract through inclusion, and any types added to the contract through importing other schemas. You can also make the runtime aware of additional types as described in Adding Classes to the Runtime Marshaller on page 110.

Unmarshaling

If the Java property for an `any` element has its lax set to `false` or the property is not specified, the runtime will only accept DOM `Element` objects. Attempting to use any other type of object will result in a marshaling error.

If the Java property for an `any` element has its lax set to `true`, the runtime uses its internal map between Java data types and the XML Schema constructs they represent to determine the XML structure to write to the wire. If it knows the class and can map it to an XML Schema construct, it writes out the data and inserts an `xsi:type` attribute to identify the type of data the element contains.

If the runtime cannot map the Java object to a known XML Schema construct, it will throw a marshaling exception. You can add types to the runtime's map using the method described in Adding Classes to the Runtime Marshaller on page 110.

Using XML Schema anyType

Overview

The XML Schema type xsd:anyType is the root type for all XML Schema types. All of the primitives are derivatives of this type as are all user defined complex types. As a result, elements defined as being of xsd:anyType can contain data in the form of any of the XML Schema primitives as well as any complex type defined in a schema document.

In Java the closest matching type is the `Object` class. It is the class from which all other Java classes are sub-typed.

Using in XML Schema

You use the xsd:anyType type as you would any other XML Schema complex type. It can be used as the value of an `element` element's `type` element. It can also be used as the base type from which other types are defined.

Example 100 on page 179 shows an example of a complex type that contains an element of type xsd:anyType.

Example 100. Complex Type with a Wild Card Element

```
<complexType name="wildStar">
  <sequence>
    <element name="name" type="xsd:string" />
    <element name="ship" type="xsd:anyType" />
  </sequence>
</complexType>
```

Mapping to Java

Elements that are of type xsd:anyType are mapped to `Object` objects. Example 101 on page 179 shows the mapping of Example 100 on page 179 to a Java class.

Example 101. Java Representation of a Wild Card Element

```
public class WildStar {

    @XmlElement(required = true)
    protected String name;
    @XmlElement(required = true)
    protected Object ship;

    public String getName() {
        return name;
    }
    public void setName(String value) {
        this.name = value;
    }

    public Object getShip() {
        return ship;
    }

    public void setShip(Object value) {
        this.ship = value;
    }
}
```

This mapping allows you to place any data into the property representing the wild card element. The Artix ESB runtime handles the marshaling and unmarshaling of the data into usable Java representation.

Marshaling

When Artix ESB marshals XML data into Java types, it attempts to marshal anyType elements into known JAXB objects. To determine if it is possible to marshal an anyType element into a JAXB generated object, the runtime inspects the element's `xsi:type` attribute to determine actual type used to construct the data in the element. If the `xsi:type` attribute is not present, the runtime will attempt to identify the element's actual data type by introspection. If the element's actual data type is determined to be one of the types known by the application's JAXB context, the element will be marshaled into a JAXB object of the proper type.

If the runtime cannot determine the actual data type of the element or the actual data type of the element is not a known type, the runtime marshals the content into a `org.w3c.dom.Element` object. You will then need to work with the element's content using the DOM APIs.

An application's runtime generally knows about all of the types generated from the schema's included in its contract. This includes the types defined in the contract's `wsdl:types` element, any data types added to the contract through inclusion, and any types added to the contract through importing other schemas. You can also make the runtime aware of additional types using the method described in Adding Classes to the Runtime Marshaller on page 110.

Unmarshalling

When Artix ESB unmarshals Java types into XML data, it uses its internal map between Java data types and the XML Schema constructs they represent to determine the XML structure to write to the wire. If it knows the class and can map it to an XML Schema construct, it writes out the data and inserts an `xsi:type` attribute to identify the type of data the element contains. If the data is stored in a `org.w3c.dom.Element` object, the runtime will write the XML structure represented by the object but it will not include an `xsi:type` attribute.

If the runtime cannot map the Java object to a known XML Schema construct, it will throw a marshaling exception. You can add types to the runtime's map using the method described in Adding Classes to the Runtime Marshaller on page 110.

Using Unbound Attributes

Overview

XML Schema has a mechanism that allows you to leave a place holder for an arbitrary attribute in a complex type definition. Using this mechanism, you could define a complex type that can have any attribute. For example, you could create a type that defines the elements <robot name="epsilon" />, <robot age="10000" />, or <robot type="weevil" /> without specifying the three attributes. This can be particularly useful when you need to provide for a bit of flexibility in your data.

Defining in XML Schema

Undeclared attributes are defined in XML Schema using the `anyAttribute` element. It can be used wherever an attribute element can be used. The `anyAttribute` element has no attributes as shown in Example 102 on page 182.

Example 102. Complex Type with an Undeclared Attribute

```
<complexType name="arbitter">
  <sequence>
    <element name="name" type="xsd:string" />
    <element name="rate" type="xsd:float" />
  </sequence>
  <anyAttribute />
</complexType>
```

The defined type, arbitter, has two elements and can have one attribute of any type. The elements

- <officer rank="12"><name>...</name><rate>...</rate></officer>
- <lawyer type="divorce"><name>...</name><rate>...</rate></lawyer>
- <judge><name>...</name><rate>...</rate></judge>

can all be generated from the complex type arbitter.

Mapping to Java

When a complex type containing an `anyAttribute` element is mapped to Java, the code generator adds a member called otherAttributes to the generated class. otherAttributes is of type `java.util.Map<QName, String>` and it has a getter method that returns a live instance of the map. Because the map returned from the getter is live, any modifications to the map are automatically applied. Example 103 on page 183 shows the class generated for the complex type defined in Example 102 on page 182.

Example 103. Class for a Complex Type with an Undeclared Attribute

```
public class Arbitter {

    @XmlElement(required = true)
    protected String name;
    protected float rate;

    @XmlAnyAttribute
    private Map<QName, String> otherAttributes = new HashMap<QName, String>();

    public String getName() {
        return name;
    }

    public void setName(String value) {
        this.name = value;
    }

    public float getRate() {
        return rate;
    }

    public void setRate(float value) {
        this.rate = value;
    }

    public Map<QName, String> getOtherAttributes() {
        return otherAttributes;
    }

}
```

Working with undeclared attributes

The otherAttributes member of the generated class expects to be populated with a `Map` object. The map is keyed using `QNames`. Once you get the map , you can access any attributes set on the object and set new attributes on the object.

Example 104 on page 184 shows code for working with undeclared attributes.

Example 104. Working with Undeclared Attributes

```
Arbitter judge = new Arbitter();
Map<QName, String> otherAtts = judge.getOtherAttributes(); ❶

QName at1 = new QName("test.apache.org", "house"); ❷
QName at2 = new QName("test.apache.org", "veteran");

otherAtts.put(at1, "Cape"); ❸
otherAtts.put(at2, "false");

String vetStatus = otherAtts.get(at2); ❹
```

The code in Example 104 on page 184 does the following:

❶ Gets the map containing the undeclared attributes.

❷ Creates QNames to work with the attributes.

❸ Sets the values for the attributes into the map.

❷ Retrieves the value for one of the attributes.

Using Type Substitution

There are a number of general topics that apply to how Artix ESB handles type mapping.

Substitution Groups in XML Schema

Overview

A substitution group is a feature of XML schema that allows you to specify elements that can replace another element in documents generated from that schema. The replaceable element is called the head element and must be defined in the schema's global scope. The elements of the substitution group must be of the same type as the head element or a type that is derived from the head element's type.

In essence, a substitution group allows you to build a collection of elements that can be specified using a generic element. For example, if you are building an ordering system for a company that sells three types of widgets you may define a generic widget element that contains a set of common data for all three widget types. Then you could define a substitution group that contains a more specific set of data for each type of widget. In your contract you could then specify the generic widget element as a message part instead of defining a specific ordering operation for each type of widget. When the actual message is built, the message can then contain any of the elements of the substitution group.

Syntax

Substitution groups are defined using the `substitutionGroup` attribute of the XML Schema `element` element. The value of the `substitutionGroup` attribute is the name of the element that the element being defined can replace. For example if your head element was widget, then by adding the attribute substitutionGroup="widget" to an element named `woodWidget` would specify that anywhere `widget` was used, you could substitute `woodWidget`. This is shown in Example 105 on page 186.

Example 105. Using a Substitution Group

```
<element name="widget" type="xsd:string" />
<element name="woodWidget" type="xsd:string"
         substitutionGroup="widget" />
```

Type restrictions

The elements of a substitution group must be of the same type as the head element or of a type derived from the head element's type. For example, if the head element is of type xsd:int all members of the substitution group must be of type xsd:int or of type derived from xsd:int. You could also define a substitution group similar to the one shown in Example 106 on page 187 where the elements of the substitution group are of types derived from the head element's type.

Example 106. Substitution Group with Complex Types

```
<complexType name="widgetType">
  <sequence>
    <element name="shape" type="xsd:string" />
    <element name="color" type="xsd:string" />
  </sequence>
</complexType>
<complexType name="woodWidgetType">
  <complexContent>
    <extension base="widgetType">
      <sequence>
        <element name="woodType" type="xsd:string" />
      </sequence>
    </extension>
  </complexContent>
</complexType>
<complexType name="plasticWidgetType">
  <complexContent>
    <extension base="widgetType">
      <sequence>
        <element name="moldProcess" type="xsd:string" />
      </sequence>
    </extension>
  </complexContent>
</complexType>
<element name="widget" type="widgetType" />
<element name="woodWidget" type="woodWidgetType"
         substitutionGroup="widget" />
<element name="plasticWidget" type="plasticWidgetType"
         substitutionGroup="widget" />
<complexType name="partType">
  <sequence>
    <element ref="widget" />
  </sequence>
</complexType>
<element name="part" type="partType" />
```

The head element of the substitution group, `widget`, is defined as being of type widgetType. Each element of the substitution group then extends widgetType to include data specific to ordering the specific type of widget.

Based on the schema in Example 106 on page 187, the `part` elements in Example 107 on page 188 are valid.

Example 107. XML Document using a Substitution Group

```
<part>
  <widget>
    <shape>round</shape>
    <color>blue</color>
  </widget>
</part>
<part>
  <plasticWidget>
    <shape>round</shape>
    <color>blue</color>
    <moldProcess>sandCast</moldProcess>
  </plasticWidget>
</part>
<part>
  <woodWidget>
    <shape>round</shape>
    <color>blue</color>
    <woodType>elm</woodType>
  </woodWidget>
</part>
```

Abstract head elements

You can define an abstract head element that can never appear in a document produced using your schema. Abstract head elements are similar to abstract classes in Java in that they are used as the basis for defining more specific implementations of a generic class. Abstract heads also prevent the use of the generic element in the final product.

You declare an abstract head element by setting the `abstract` attribute of `element` element to `true` as shown in Example 108 on page 188. Using this schema, a valid `review` element could contain either a `positiveComment` element or a `negativeComment` element, but not a `comment` element.

Example 108. Abstract Head Definition

```
<element name="comment" type="xsd:string" abstract="true" />
<element name="positiveComment" type="xsd:string"
         substitutionGroup="comment" />
<element name="negtiveComment" type="xsd:string"
         substitutionGroup="comment" />
<element name="review">
  <complexContent>
    <all>
      <element name="custName" type="xsd:string" />
      <element name="impression" ref="comment" />
    </all>
  </complexContent>
</element>
```

Substitution Groups in Java

Overview

Artix ESB, as specified by the JAXB specification, supports substitution groups using Java's native class hierarchy and the ability of the `JAXBElement` class' support for wildcard definitions. Because the members of a substitution group must all share a common base type, the classes generated to support the elements' types will also share a common base type. In addition, Artix ESB maps instances of the head element to `JAXBElement<? extends T>` properties.

Generated object factory methods

The object factory generated to support a package containing a substitution group has methods for each of the elements in the substitution group. For each of the members of the substitution group, except for the head element, the `@XmlElementDecl` annotation decorating the object factory method includes the two additional properties described in Table 18 on page 190.

Table 18. Properties for Declaring a JAXB Element is a Member of a Substitution Group

Property	Description
substitutionHeadNamespace	Specifies the namespace in which the head element is defined.
substitutionHeadName	Specifies the value of the head element's `name` attribute.

The object factory method for the head element of the substitution group's `@XmlElementDecl` will just contain the default namespace property and the default name property.

In addition to the element instantiation methods, the object factory contains a method for instantiating an object representing the head element. If the members of the substitution group are all of complex types, the object factory will also contain methods for instantiating instances of each complex type used.

Example 109 on page 190 shows the object factory method for the substitution group defined in Example 106 on page 187.

Example 109. Object Factory Method for a Substitution Group

```
public class ObjectFactory {

    private final static QName _Widget_QNAME = new QName(...);
    private final static QName _PlasticWidget_QNAME = new QName(...);
    private final static QName _WoodWidget_QNAME = new QName(...);

    public ObjectFactory() {
    }

    public WidgetType createWidgetType() {
        return new WidgetType();
    }

    public PlasticWidgetType createPlasticWidgetType() {
        return new PlasticWidgetType();
    }

    public WoodWidgetType createWoodWidgetType() {
        return new WoodWidgetType();
    }

    @XmlElementDecl(namespace="...", name = "widget")
    public JAXBElement<WidgetType> createWidget(WidgetType value) {
        return new JAXBElement<WidgetType>(_Widget_QNAME, WidgetType.class, null, value);
    }

    @XmlElementDecl(namespace = "...", name = "plasticWidget", substitutionHeadNamespace =
 "...", substitutionHeadName = "widget")
    public JAXBElement<PlasticWidgetType> createPlasticWidget(PlasticWidgetType value) {
        return new JAXBElement<PlasticWidgetType>(_PlasticWidget_QNAME, PlasticWidget
Type.class, null, value);
    }

    @XmlElementDecl(namespace = "...", name = "woodWidget", substitutionHeadNamespace =
"...", substitutionHeadName = "widget")
    public JAXBElement<WoodWidgetType> createWoodWidget(WoodWidgetType value) {
        return new JAXBElement<WoodWidgetType>(_WoodWidget_QNAME, WoodWidgetType.class,
null, value);
    }

}
```

Substitution groups in interfaces

If the head element of a substitution group is used as a message part in one of an operation's messages, the resulting method parameter will be an object of the class generated to support that element. It will not necessarily be an instance of the `JAXBElement<? extends T>` class. The runtime relies on Java's native type hierarchy to support the type substitution. Java will catch any attempts to use unsupported types.

Example 111 on page 192 shows the SEI generated for the interface shown in Example 110 on page 192. The interface uses the substitution group defined in Example 106 on page 187.

Example 110. WSDL Interface Using a Substitution Group

```
<message name="widgetMessage">
    <part name="widgetPart" element="xsd1:widget" />
  </message>
  <message name="numWidgets">
    <part name="numInventory" type="xsd:int" />
  </message>
  <message name="badSize">
    <part name="numInventory" type="xsd:int" />
  </message>
  <portType name="orderWidgets">
    <operation name="placeWidgetOrder">
      <input message="tns:widgetOrder" name="order" />
      <output message="tns:widgetOrderBill" name="bill" />
      <fault message="tns:badSize" name="sizeFault" />
    </operation>
    <operation name="checkWidgets">
      <input message="tns:widgetMessage" name="request" />
      <output message="tns:numWidgets" name="response" />
    </operation>
  </portType>
```

Example 111. Generated Interface Using a Substitution Group

```
@WebService(targetNamespace = "...", name = "orderWidgets")
public interface OrderWidgets {

    @SOAPBinding(parameterStyle = SOAPBinding.ParameterStyle.BARE)
    @WebResult(name = "numInventory", targetNamespace = "", partName = "numInventory")
    @WebMethod
    public int checkWidgets(
        @WebParam(partName = "widgetPart", name = "widget", targetNamespace = "...")
        com.widgetvendor.types.widgettypes.WidgetType widgetPart
    );
}
```

Important

To ensure that the runtime knows about all of the classes needed to support the element substitution, You will need to configure your application to load the extra classes. See Adding Classes to the

Runtime Marshaller on page 110 for information on the required configuration.

Substitution groups in complex types

When the head element of a substitution group is used as an element in a complex type, the code generator maps the element to a `JAXBElement<? extends T>` property. It does not map it to a property containing an instance of the generated class generated to support the substitution group.

For example the complex type defined in Example 112 on page 193 would result in the Java class shown in Example 113 on page 193. The complex type uses the substitution group defined in Example 106 on page 187.

Example 112. Complex Type Using a Substitution Group

```
<complexType name="widgetOrderInfo">
  <sequence>
    <element name="amount" type="xsd:int"/>
    <element ref="xsd1:widget"/>
  </sequence>
</complexType>
```

Example 113. Java Class for a Complex Type Using a Substitution Group

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "widgetOrderInfo", propOrder =
{"amount","widget",})
public class WidgetOrderInfo {

    protected int amount;
    @XmlElementRef(name = "widget", namespace = "...", type
= JAXBElement.class)
    protected JAXBElement<? extends WidgetType> widget;
    public int getAmount() {
        return amount;
    }

    public void setAmount(int value) {
        this.amount = value;
    }

    public JAXBElement<? extends WidgetType> getWidget() {
        return widget;
    }

    public void setWidget(JAXBElement<? extends WidgetType>
value) {
        this.widget = ((JAXBElement<? extends WidgetType> )
value);
    }

}
```

Setting a substitution group property

How you work with a substitution group depends on whether the code generator mapped it to a straight Java class or a `JAXBElement<? extends T>` class. When the element is simply mapped to an object of the generated value class, you can work with the object as you would any other Java object that is part of a type hierarchy. You can substitute any of the subclasses for the parent class. You can inspect the object to determine its exact class and cast it appropriately.

Tip

The JAXB specification recommends that you use the object factory methods for instantiating objects of the generated classes. However, you do not have to follow this recommendation in your application code.

When the code generators create a `JAXBElement<? extends T>` object to hold instances of a substitution group, you must wrap the element's value in a `JAXBElement<? extends T>` object. The easiest way to do this is by using the element creation methods provided by the object factory. They provide an easy means for creating an element based on its value.

Example 114 on page 194 shows code for setting an instance of a substitution group.

Example 114. Setting a Member of a Substitution Group

```
ObjectFactory of = new ObjectFactory(); ❶
PlasticWidgetType pWidget = of.createPlasticWidgetType(); ❷
pWidget.setShape = "round';
pWidget.setColor = "green";
pWidget.setMoldProcess = "injection";

JAXBElement<PlasticWidgetType> widget = of.createPlasticWidget(pWidget); ❸

WidgetOrderInfo order = of.createWidgetOrderInfo(); ❹
order.setWidget(widget); ❺
```

The code in Example 114 on page 194 does the following:

❶ Instantiates an object factory.

❷ Instantiates a `PlasticWidgetType` object.

❸ Instantiates a `JAXBElement<PlasticWidgetType>` object to hold a plastic widget element.

❹ Instantiates a `WidgetOrderInfo` object.

❺ Sets the `WidgetOrderInfo` object's widget to the `JAXBElement` object holding the plastic widget element.

Getting the value of a substitution group property

The object factory methods do not help when extracting the element's value from a `JAXBElement<? extends T>` object. You need to use the `JAXBElement<? extends T>` object's `getValue()` method. To determine the type of object returned by the `getValue()` method you have several options:

- Use the `isInstance()` method of all the possible classes to determine the class of the element's value object.
- Use the `JAXBElement<? extends T>` object's `getName()` method to determine the element's name.

  The `getName()` method returns a QName. Using the local name of the element, you should be able to determine the proper class for the value object.
- Use the `JAXBElement<? extends T>` object's `getDeclaredType()` method to determine the class of the value object.

  The `getDeclaredType()` method returns the `Class` object of the element's value object. There is a possibility that the `getDeclaredType()` method will return the base class for the head element regardless of the actual class of the value object.

Example 115 on page 196 shows code retrieving the value from a substitution group. To determine the proper class of the element's value object the example uses the element's `getName()` method.

Example 115. Getting the Value of a Member of the Substitution Group

```
String elementName = order.getWidget().getName().getLocalPart();
if (elementName.equals("woodWidget")
{
  WoodWidgetType widget=order.getWidget().getValue();
}
else if (elementName.equals("plasticWidget")
{
  PlasticWidgetType widget=order.getWidget().getValue();
}
else
{
  WidgetType widget=order.getWidget().getValue();
}
```

Widget Vendor Example

This section shows an example of substitution groups being used in Artix ESB to solve a real world application. A service and consumer are developed using the widget substitution group defined in Example 106 on page 187. The service offers two operations: `checkWidgets` and `placeWidgetOrder`.

Example 116 on page 197 shows the interface for the ordering service.

Example 116. Widget Ordering Interface

```
<message name="widgetOrder">
  <part name="widgetOrderForm" type="xsd1:widgetOrderInfo"/>
</message>
<message name="widgetOrderBill">
  <part name="widgetOrderConformation"
        type="xsd1:widgetOrderBillInfo"/>
</message>
<message name="widgetMessage">
  <part name="widgetPart" element="xsd1:widget" />
</message>
<message name="numWidgets">
  <part name="numInventory" type="xsd:int" />
</message>
<portType name="orderWidgets">
  <operation name="placeWidgetOrder">
    <input message="tns:widgetOrder" name="order"/>
    <output message="tns:widgetOrderBill" name="bill"/>
  </operation>
  <operation name="checkWidgets">
    <input message="tns:widgetMessage" name="request" />
    <output message="tns:numWidgets" name="response" />
  </operation>
</portType>
```

Example 117 on page 197 shows the generated Java SEI for the interface.

Example 117. Widget Ordering SEI

```
@WebService(targetNamespace = "http://widgetVendor.com/widgetOrderForm", name = "orderWid
gets")
public interface OrderWidgets {

    @SOAPBinding(parameterStyle = SOAPBinding.ParameterStyle.BARE)
    @WebResult(name = "numInventory", targetNamespace = "", partName = "numInventory")
    @WebMethod
    public int checkWidgets(
        @WebParam(partName = "widgetPart", name = "widget", targetNamespace = "http://wid
getVendor.com/types/widgetTypes")
        com.widgetvendor.types.widgettypes.WidgetType widgetPart
    );

    @SOAPBinding(parameterStyle = SOAPBinding.ParameterStyle.BARE)
    @WebResult(name = "widgetOrderConformation", targetNamespace = "", partName = "widget
OrderConformation")
    @WebMethod
    public com.widgetvendor.types.widgettypes.WidgetOrderBillInfo placeWidgetOrder(
        @WebParam(partName = "widgetOrderForm", name = "widgetOrderForm", targetNamespace
= "")
        com.widgetvendor.types.widgettypes.WidgetOrderInfo widgetOrderForm
    ) throws BadSize;
}
```

Note

Because the example is to demonstrate the use of substitution groups, some of the business logic is not shown.

The checkWidgets Operation

Overview

`checkWidgets` is a simple operation that has a parameter that is the head member of a substitution group. This operation demonstrates how to deal with individual parameters that are members of a substitution group. The consumer must ensure that the parameter is a valid member of the substitution group. The service must properly determine which member of the substitution group was sent in the request.

Consumer implementation

The generated method signature uses the Java class supporting the type of the substitution group's head element. Because members of a substitution group must be either of the same type or of a type derived from the type of the head element, the Java classes generated to support the types of all of the members of the substitution group share inherit from the Java class supporting the head element's type. Java's type hierarchy natively supports using subclasses in place of the parent class.

Because of how Artix ESB generates the types for a substitution group and Java's type hierarchy, the client can invoke `checkWidgets()` without using any special code. When developing the logic to invoke `checkWidgets()` you can pass in an object of one of the classes generated to support the widget substitution group. The service's implementation should be able to handle it correctly.

Example 118 on page 199 shows a consumer invoking `checkWidgets()`.

Example 118. Consumer Invoking `checkWidgets()`

```
System.out.println("What type of widgets do you want to order?");
System.out.println("1 - Normal");
System.out.println("2 - Wood");
System.out.println("3 - Plastic");
System.out.println("Selection [1-3]");
String selection = reader.readLine();
String trimmed = selection.trim();
char widgetType = trimmed.charAt(0);
switch (widgetType)
{
  case '1':
  {
    WidgetType widget = new WidgetType();
    ...
    break;
  }
  case '2':
  {
    WoodWidgetType widget = new WoodWidgetType();
    ...
    break;
  }
  case '3':
  {
    PlasticWidgetType widget = new PlasticWidgetType();
    ...
    break;
  }
  default :
    System.out.println("Invaid Widget Selection!!");
}

proxy.checkWidgets(widgets);
```

Service implementation

The service's implementation of `checkWidgets()` gets a widget description as a `WidgetType` object, checks the inventory of widgets, and returns the number of widgets in stock. Because all of the classes used to implement the substitution group inherit from the same base class, you can implement `checkWidgets()` without using any JAXB specific APIs.

Because all of the types defining the different members of the substitution group for `widget` extend the `WidgetType` class, you can use `instanceof` to determine what type of widget was passed in and simply cast the *`widgetPart`* object into the more restrictive type if appropriate. Once you have the proper type of object, you can check the inventory of the right kind of widget.

Example 119 on page 200 shows a possible implementation.

Example 119. Service Implementation of `checkWidgets()`

```
public int checkWidgets(WidgetType widgetPart)
{
  if (widgetPart instanceof WidgetType)
  {
    return checkWidgetInventory(widgetType);
  }
  else if (widgetPart instanceof WoodWidgetType)
  {
    WoodWidgetType widget = (WoodWidgetType)widgetPart;
    return checkWoodWidgetInventory(widget);
  }
  else if (widgetPart instanceof PlasticWidgetType)
  {
    PlasticWidgetType widget = (PlasticWidgetType)widgetPart;
    return checkPlasticWidgetInventory(widget);
  }
}
```

The placeWidgetOrder Operation

Overview

`placeWidgetOrder` uses two complex types containing the substitution group. This operation demonstrates how one might go about using such a structure in a Java implementation. Both the consumer and the service have to get and set members of a substitution group.

Consumer implementation

To invoke `placeWidgetOrder()` the consumer needs to construct a widget order that contains one element of the widget substitution group. When adding the widget to the order, the consumer should use the object factory methods generated for each element of the substitution group to ensure that the runtime and the service can correctly process the order. For example, if an order is being placed for a plastic widget, `ObjectFactory.createPlasticWidget()` should be used to create the element before adding it to the order.

Example 120 on page 202 shows consumer code for setting the widget property of the `WidgetOrderInfo` object.

Example 120. Setting a Substitution Group Member

```
ObjectFactory of = new ObjectFactory();

WidgetOrderInfo order = new of.createWidgetOrderInfo();
...
System.out.println();
System.out.println("What color widgets do you want to order?");
String color = reader.readLine();
System.out.println();
System.out.println("What shape widgets do you want to order?");
String shape = reader.readLine();
System.out.println();
System.out.println("What type of widgets do you want to or
der?");
System.out.println("1 - Normal");
System.out.println("2 - Wood");
System.out.println("3 - Plastic");
System.out.println("Selection [1-3]");
String selection = reader.readLine();
String trimmed = selection.trim();
char widgetType = trimmed.charAt(0);
switch (widgetType)
{
  case '1':
  {
    WidgetType widget = of.createWidgetType();
    widget.setColor(color);
    widget.setShape(shape);
   JAXB<WidgetType> widgetElement = of.createWidget(widget);

    order.setWidget(widgetElement);
    break;
  }
  case '2':
  {
    WoodWidgetType woodWidget = of.createWoodWidgetType();
    woodWidget.setColor(color);
    woodWidget.setShape(shape);
    System.out.println();
   System.out.println("What type of wood are your widgets?");

    String wood = reader.readLine();
    woodWidget.setWoodType(wood);
    JAXB<WoodWidgetType> widgetElement = of.createWoodWid
get(woodWidget);
    order.setWoodWidget(widgetElement);
    break;
  }
  case '3':
  {
    PlasticWidgetType plasticWidget = of.createPlasticWidget
Type();
    plasticWidget.setColor(color);
    plasticWidget.setShape(shape);
    System.out.println();
    System.out.println("What type of mold to use for your
                        widgets?");
    String mold = reader.readLine();
    plasticWidget.setMoldProcess(mold);
    JAXB<WidgetType> widgetElement = of.createPlasticWid
get(plasticWidget);
    order.setPlasticWidget(widgetElement);
    break;
  }
  default :
    System.out.println("Invaid Widget Selection!!");
    }
```

Service implementation

The `placeWidgetOrder()` method receives an order in the form of a `WidgetOrderInfo` object, processes the order, and returns a bill to the consumer in the form of a `WidgetOrderBillInfo` object. The orders can be for either a plain widget, a plastic widget, or a wooden widget. The type of widget ordered is determined by what type of object is stored in *widgetOrderForm* object's widget property. The widget property is a substitution group and can contain either a `widget` element, a `woodWidget` element, or a `plasticWidget` element.

The implementation has to determine which of the possible elements is stored in the order. This can be accomplished using the `JAXBElement<? extends T>` object's `getName()` method to determine the element's QName. The QName can then be used to determine which element in the substitution group is in the order. Once you know which element is included in the bill, you can extract its value into the proper type of object.

Example 121 on page 204 shows a possible implementation.

Example 121. Implementation of placeWidgetOrder()

```
public com.widgetvendor.types.widgettypes.WidgetOrderBillInfo placeWidgetOrder(WidgetOrderInfo
 widgetOrderForm)
{
❶  ObjectFactory of = new ObjectFactory();

❷  WidgetOrderBillInfo bill = new WidgetOrderBillInfo()

   // Copy the shipping address and the number of widgets
   // ordered from widgetOrderForm to bill
   ...

❸  int numOrdered = widgetOrderForm.getAmount();

❹  String elementName = widgetOrderForm.getWidget().getName().getLocalPart();
❺  if (elementName.equals("woodWidget")
  {
❻    WoodWidgetType widget=order.getWidget().getValue();
    buildWoodWidget(widget, numOrdered);

    // Add the widget info to bill
❼    JAXBElement<WoodWidgetType> widgetElement = of.createWoodWidget(widget);
❽    bill.setWidget(widgetElement);

    float amtDue = numOrdered * 0.75;
❾    bill.setAmountDue(amtDue);
  }
  else if (elementName.equals("plasticWidget")
  {
    PlasticWidgetType widget=order.getWidget().getValue();
    buildPlasticWidget(widget, numOrdered);

    // Add the widget info to bill
    JAXBElement<PlasticWidgetType> widgetElement = of.createPlasticWidget(widget);
    bill.setWidget(widgetElement);

    float amtDue = numOrdered * 0.90;
    bill.setAmountDue(amtDue);
  }
  else
  {
    WidgetType widget=order.getWidget().getValue();
    buildWidget(widget, numOrdered);

    // Add the widget info to bill
    JAXBElement<WidgetType> widgetElement = of.createWidget(widget);
    bill.setWidget(widgetElement);

    float amtDue = numOrdered * 0.30;
    bill.setAmountDue(amtDue);
  }

  return(bill);
}
```

The code in Example 121 on page 204 does the following:

❶ Instantiates an object factory to create elements.

❷ Instantiates a `WidgetOrderBillInfo` object to hold the bill.

❸ Gets the number of widgets ordered.

❹ Gets the local name of the element stored in the order.

❺ Checks to see if the element is a `woodWidget` element.

❻ Extracts the value of the element from the order into the proper type of object.

❼ Creates a `JAXBElement<T>` object to be placed into the bill.

❽ Sets the bill object's widget property.

❾ Sets the bill object's amountDue property.

Customizing How Types are Generated

The JAXB default mappings cover most uses of XML Schema used when using service-oriented design to create Java applications. For instances where the default mappings are insufficient, JAXB provides an extensive customization mechanism.

Important

JAXB customizations are ignored if you are using the **wsdlgen** tool.

Basics of Customizing Type Mappings

Overview

You customize how the code generators map XML Schema constructs to Java constructs using XML elements that are defined by the JAXB specification. These elements can be specified in-line with XML Schema constructs. If you cannot, or do not want to, modify the XML Schema definitions, you can also specify the customizations in external binding document.

Namespace

The elements used to customize the JAXB data bindings are defined in the namespace http://java.sun.com/xml/ns/jaxb. You will have to add a namespace declaration similar to Example 122 on page 208 in the root element of all XML documents defining JAXB customizations.

Example 122. JAXB Customization Namespace

```
xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
```

Version declaration

When using the JAXB customizations, you must indicate the JAXB version being used. This is done by adding an `jaxb:version` attribute to the root element of the external binding declaration. If you are using in-line customization, you need to include the `jaxb:version` attribute in the `schema` element containing the customizations. The value of the attribute is always `2.0`.

Example 123 on page 208 shows an example of the `jaxb:version` attribute used in a `schema` element.

Example 123. Specifying the JAXB Customization Version

```
< schema ...
        jaxb:version="2.0">
```

Using in-line customization

The most direct way to customize how the code generators map XML Schema constructs to Java constructs is to add the customization elements directly to the XML Schema definitions. The JAXB customization elements are placed inside of the `xsd:appinfo` element of the XML schema construct that is being modified.

Example 124 on page 209 shows an example of a schema containing in-line JAXB customization.

Example 124. Customized XML Schema

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <complexType name="size">
    <annotation>
      <appinfo>
        <jaxb:class name="widgetSize" />
      </appinfo>
    </annotation>
    <sequence>
      <element name="longSize" type="xsd:string" />
      <element name="numberSize" type="xsd:int" />
    </sequence>
  </complexType>
<schema>
```

Using an external binding declaration

When you cannot, or do not want to, add make changes to the XML Schema document that defines your type, you can specify the customizations using an external binding declaration. An external binding declaration consists of a number of nested `jaxb:bindings` elements. Example 125 on page 209 shows the syntax of an external binding declaration.

Example 125. JAXB External Binding Declaration Syntax

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings [schemaLocation="schemaUri" | wsdlLocation="wsdlUri">
    <jaxb:bindings node="nodeXPath">
      binding declaration
    </jaxb:bindings>
    ...
  </jaxb:bindings>
<jaxb:bindings>
```

The `schemaLocation` attribute and the `wsdlLocation` attribute are used to identify the schema document to which the modifications are applied. You use the `schemaLocation` attribute if you are generating code from a schema document. You use the `wsdlLocation` attribute if you are generating code from a WSDL document.

The `node` attribute is used to identify the specific XML schema construct that is to be modified. It is an XPath statement that resolves to an XML Schema element.

Given the schema document `widgetSchema.xsd`, shown in Example 126 on page 210, the external binding declaration shown in Example 127 on page 210 modifies the generation of the complex type size.

Example 126. XML Schema File

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        version="1.0">
  <complexType name="size">
    <sequence>
      <element name="longSize" type="xsd:string" />
      <element name="numberSize" type="xsd:int" />
    </sequence>
  </complexType>
<schema>
```

Example 127. External Binding Declaration

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings schemaLocation="wsdlSchema.xsd">
    <jaxb:bindings node="xsd:complexType[@name='size']">
        <jaxb:class name="widgetSize" />
    </jaxb:bindings>
  </jaxb:bindings>
<jaxb:bindings>
```

You instruct the code generators to use the external binging declaration using the artix wsdl2java tool's `-b` *`binding-file`* option as shown below:

```
artix wsdl2java -b widgetBinding.xml widget.wsdl
```

Specifying the Java Class of an XML Schema Primitive

Overview

By default, XML Schema types are mapped to Java primitive types. While this is the most logical mapping between XML Schema and Java, it does not always satisfy the requirements of the application developer. You may want to map an XML Schema primitive type to a Java class that can hold extra information. You may want to map an XML primitive type to a class that allows for simple type substitution.

The JAXB `javaType` customization element allows you to customize the mapping between an XML Schema primitive type and a Java primitive type. It can be used to customize the mappings at both the global level and the individual instance level. You can place the `javaType` element as part of a simple type definition or the definition of a part of a complex type.

When using the `javaType` customization element you need to specify methods for converting the XML representation of the primitive type to and from the target Java class. Some mappings have default conversion methods. For instances where there are not default mappings, Artix ESB provides JAXB methods to ease the development of the needed methods.

Syntax

The `javaType` customization element takes four attributes. Table 19 on page 211 describes these attributes.

Table 19. Attributes for Customizing the Generation of a Java Class for an XML Schema Type

Attribute	Required	Description
`name`	Yes	Specifies the name of the Java class to which the XML Schema primitive type will be mapped. It must be a valid Java class name or the name of a Java primitive type. You are responsible for ensuring that this class exists and is accessible to your application. The code generator will not check for this class.
`xmlType`	No	Specifies the XML Schema primitive type that is being customized. This attribute is only used when the `javaType` element is used as a child of the `globalBindings` element.
`parseMethod`	No	Specifies method responsible for parsing the string-based XML representation of the data into an instance of the Java class. For more information see Specifying the converters on page 214.
`printMethod`	No	Specifies method responsible for converting a Java object to the string-based XML representation of the data. For more information see Specifying the converters on page 214.

The `javaType` customization element can be used in three ways:

to modify all instances of an XML Schema primitive type
: The `javaType` element modifies all instances of an XML Schema type in the schema document when used as a child of the `globalBindings` customization element. When used in this manner, you must specify a value for the `xmlType` attribute that identifies the XML Schema primitive type being modified.

  Example 128 on page 212 shows an in-line global customization that instructs the code generators to use `java.lang.Integer` for all instances of xsd:short in the schema.

Example 128. Global Primitive Type Customization

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <annotation>
    <appinfo>
      <jaxb:globalBindings ...>
        <jaxb:javaType name="java.lang.Integer"
                       xmlType="xsd:short" />
      </globalBindings
    </appinfo>
  </annotation>
  ...
</schema>
```

to modify a simple type definition
: The `javaType` element modifies the class generated for all instances of an XML simple type when it is applied to a named simple type definition. When you use the `javaType` element to modify a simple type definition, you do not use the `xmlType` attribute.

  Example 129 on page 212 shows an external binding file that modifies the generation of a simple type named zipCode.

Example 129. Binding File for Customizing a Simple Type

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings wsdlLocation="widgets.wsdl">
    <jaxb:bindings node="xsd:simpleType[@name='zipCode']">
        <jaxb:javaType name="com.widgetVendor.widgetTypes.zipCodeType"
                       parseMethod="com.widgetVendor.widgetTypes.support.parseZipCode"
                       printMethod="com.widgetVendor.widgetTypes.support.printZipCode" />
    </jaxb:bindings>
  </jaxb:bindings>
<jaxb:bindings>
```

to modify an element or attribute of a complex type definition

The `javaType` can be applied to individual parts of a complex type definition by including it as part of a JAXB property customization. The `javaType` element is placed as a child to the property's `baseType` element. When you use the `javaType` element to modify a specific part of a complex type definition, you do not use the `xmlType` attribute.

Example 130 on page 213 shows a binding file that modifies an element of a complex type.

Example 130. Binding File for Customizing an Element in a Complex Type

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings schemaLocation="enumMap.xsd">
    <jaxb:bindings node="xsd:ComplexType[@name='widgetOrderInfo']">
      <jaxb:bindings node="xsd:element[@name='cost']">
        <jaxb:property>
          <jaxb:baseType>
            <jaxb:javaType name="com.widgetVendor.widgetTypes.costType"
                           parseMethod="parseCost"
                           printMethod="printCost" >
          </jaxb:baseType>
        </jaxb:property>
      </jaxb:bindings>
    </jaxb:bindings>
  </jaxb:bindings>
<jaxb:bindings>
```

For more information on using the `baseType` element see Specifying the Base Type of an Element or an Attribute on page 229.

Specifying the converters

The Artix ESB does not know of how to convert XML Schema primitive types into random Java classes. When you use the `javaType` element to customize the mapping of an XML Schema primitive type, the code generator creates an adapter class that is used to marshal and unmarshal the customized XML Schema primitive type. A sample adapter class is shown in Example 131 on page 214.

Example 131. JAXB Adapter Class

```
public class Adapter1 extends XmlAdapter<String, javaType>
{
  public javaType unmarshal(String value)
  {
    return(parseMethod(value));
  }

  public String marshal(javaType value)
  {
    return(printMethod(value));
  }
}
```

`parseMethod` and *`printMethod`* are replaced by the value of the corresponding `parseMethod` attribute and `printMethod` attribute. The values must identify valid Java methods. You can specify the method's name in one of two ways:

- a fully qualified Java method name in the form *`packagename.ClassName.methodName`*
- a simple method name in the form *`methodName`*

  When you only provide a simple method name, the code generator assumes that the method exists in the class specified by the `javaType` element's `name` attribute.

Important

The code generators **do not** generate parse or print methods. You are responsible for supplying them. For information on developing parse and print methods see Implementing converters on page 217.

If you do not provide a value for the `parseMethod` attribute the code generator assumes that the Java class specified by the `name` attribute has a constructor whose first parameter is a Java `String` object. The generated adpater's `unmarshal()` method uses the assumed constructor to populate the Java object with the XML data.

If you do not provide a value for the `printMethod` attribute the code generator assumes that the Java class specified by the `name` attribute has a `toString()` method. The generated adpater's `marshal()` method uses the assumed `toString()` method to convert the Java object into XML data.

If the `javaType` element's `name` attribute specifies a Java primitive type, or one of the Java primitive's wrapper types, the code generators use the default converters. For more information on default converters see Default converters on page 218.

What is generated

As mentioned in Specifying the converters on page 214, using the `javaType` customization element triggers the generation of one adapter class for each customization of an XML Schema primitive type. The adapters are named in sequence using the pattern `Adapter`*`N`*. So if you specify two primitive type customizations, the code generators will create two adapter classes:`Adapter1` and `Adapter2`.

The code generated for an XML schema construct depends on if the effected XML Schema construct is a global defined element or defined as part of a complex type.

When the XML Schema construct is a globally defined element, the object factory method generated for the type is modified from the default method as follows:

- The method is decorated with an `@XmlJavaTypeAdapter` annotation.

The annotation instructs the runtime which adapter class to use when processing instances of this element. The adapter class is specified as a class object.

- The default type is replaced by the class specified by the `javaType` element's `name` attribute.

Example 132 on page 216 shows the object factory method for an element effected by the customization shown in Example 128 on page 212.

Example 132. Customized Object Factory Method for a Global Element

```
@XmlElementDecl(namespace = "http://widgetVendor.com/types/wid
getTypes", name = "shorty")
    @XmlJavaTypeAdapter(org.w3._2001.xmlschema.Adapter1 .class)

    public JAXBElement<Integer> createShorty(Integer value)
{
        return new JAXBElement<Integer>(_Shorty_QNAME, In
teger.class, null, value);
    }
```

When the XML Schema construct is defined as part of a complex type, the generated Java property is modified as follows:

- The property is decorated with an `@XmlJavaTypeAdapter` annotation.

  The annotation instructs the runtime which adapter class to use when processing instances of this element. The adapter class is specified as a class object.

- The property's `@XmlElement` will include a type property.

  The value of the type property is the class object representing the generated object's default base type. In the case of XML Schema primitive types, the class will be `String`.

- The property is decorated with an `@XmlSchemaType` annotation.

  The annotation identifies the XML Schema primitive type of the construct.

- The default type is replaced by the class specified by the `javaType` element's `name` attribute.

Example 133 on page 217 shows the object factory method for an element effected by the customization shown in Example 128 on page 212.

Example 133. Customized Complex Type

```
public class NumInventory {

    @XmlElement(required = true, type = String.class)
    @XmlJavaTypeAdapter(Adapter1 .class)
    @XmlSchemaType(name = "short")
    protected Integer numLeft;
    @XmlElement(required = true)
    protected String size;

    public Integer getNumLeft() {
        return numLeft;
    }

    public void setNumLeft(Integer value) {
        this.numLeft = value;
    }

    public String getSize() {
        return size;
    }

    public void setSize(String value) {
        this.size = value;
    }

}
```

Implementing converters

The Artix ESB runtime has no way of knowing how to convert XML primitive types to and from the Java class specified by the `javaType` element beyond that it should call the methods specified by the `parseMethod` attribute and the `printMethod` attribute. You are responsible for providing implementations of the methods for the runtime to call. The implemented methods must be capable of working with the lexical structures of the XML primitive type.

To simplify the implementation of the data conversion methods, Artix ESB provides the `javax.xml.bind.DatatypeConverter` class. This class provides methods for parsing and printing all of the XML Schema primitive types. The parse methods take string representations of the XML data and return an instance of the default type defined in Table 12 on page 122. The print methods take an instance of the default type and return a string representation of the XML data.

The Java documentation for the `DatatypeConverter` class can be found at http://java.sun.com/webservices/docs/1.6/api/javax/xml/bind/DatatypeConverter.html.

Default converters

When you specify a Java primitive type, or one of the Java primitive type Wrapper classes, in the `javaType` element's `name` attribute, you do not have to specify values for the `parseMethod` attribute or the `printMethod` attribute. The Artix ESB runtime will substitute default converters.

The default data converters use the JAXB `DatatypeConverter` class to parse the XML data. The default converters will also provide any type casting needed to make the conversion work.

Generating Java Classes for Simple Types

Overview

By default, named simple types do not result in generated types unless they are enumerations. Elements defined using a simple type are mapped into properties of a Java primitive type. This default mapping works for most cases.

There are instances when you need to have simple types generated into Java classes. One case in particular is when you want to use type substitution.

To instruct the code generators to generate classes to for all globally defined simple types, you set the `globalBindings` customization element's `mapSimpleTypeDef` to `true`.

Adding the customization

You can instruct the code generators to create Java classes for named simple types by adding the `globalBinding` element's `mapSimpleTypeDef` attribute and setting its value to `true`.

Example 134 on page 219 shows an in-line customization to force the code generator to generate Java classes for named simple types.

Example 134. in-Line Customization to Force Generation of Java Classes for SimpleTypes

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <annotation>
    <appinfo>
      <jaxb:globalBindings mapSimpleTypeDef="true" />
    </appinfo>
  </annotation>
  ...
</schema>
```

Example 135 on page 219 shows en external binding file to customize generation of simple types.

Example 135. Binding File to Force Generation of Constants

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings schemaLocation="types.xsd">
```

```
    <jaxb:globalBindings mapSimpleTypeDef="true" />
  <jaxb:bindings>
<jaxb:bindings>
```

Important

This customization only effects *named* simple types that are defined in the *global* scope.

Generated classes

The class generated for a simple type will have one property called value. The value property will be of the Java type defined by the mappings in Primitive Types on page 122. The generated class will have a getter and a setter for the value property.

Example 137 on page 220 shows the Java class generated for the simple type defined in Example 136 on page 220.

Example 136. Simple Type for Customized Mapping

```
<simpleType name="simpleton">
  <restriction base="xsd:string">
    <maxLength value="10"/>
  </restriction>
</simpleType>
```

Example 137. Customized Mapping of a Simple Type

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "simpleton", propOrder = {"value"})
public class Simpleton {

    @XmlValue
    protected String value;

    public String getValue() {
        return value;
    }

    public void setValue(String value) {
        this.value = value;
    }

}
```

Customizing Enumeration Mapping

Overview

If you want enumerated types that are based on a schema type other than xsd:string, you need to instruct the code generator to map it. You can also control the name of the generated enumeration constants.

The customization is done using the `jaxb:typesafeEnumClass` element and one or more `jaxb:typesafeEnumMember` elements.

There you may also run into instances where the default settings for the code generator cannot create valid Java identifiers for all of the members of an enumeration. You can customize how the code generators handle this using an attribute of the `globalBindings` customization.

Member name customizer

If the code generator encounters a naming collision when generating the members of an enumeration or it cannot create a valid Java identifier for a member of the enumeration, the code generator will, by default, generate a warning and not generate a Java enum type for the enumeration.

You can alter this behavior by adding the `globalBinding` element's `typesafeEnumMemberName` attribute. The `typesafeEnumMemberName` attribute's values are described in Table 20 on page 221.

Table 20. Values for Customizing Enumeration Member Name Generation

Value	Description
`skipGeneration`(default)	Specifies that the Java enum type is not generated and a warning is given to the user.
`generateName`	Specifies that member names will be generated following the pattern `VALUE_N`. `N` starts off at one is incremented for each member of the enumeration.
`generateError`	Specifies that the code generator will generate an error if it cannot map an enumeration to a Java enum type.

Example 138 on page 222 shows an in-line customization to force the code generator to generate type safe member names.

Example 138. Customization to Force Type Safe Member Names

```
<schema targetNamespace="http://widget.com/types/widgetTypes"

        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <annotation>
    <appinfo>
      <jaxb:globalBindings typesafeEnumMemberName="generate
Name" />
    </appinfo>
  </annotation>
  ...
</schema>
```

Class customizer

The `jaxb:typesafeEnumClass` element specifies that an XML Schema enumeration should be mapped to a Java enum type. It has two attributes that are described in Table 21 on page 222. When the `jaxb:typesafeEnumClass` element is specified in-line, it must be placed inside the `xsd:annotation` element of the simple type it is modifying.

Table 21. Attributes for Customizing a Generated Enumeration Class

Attribute	Description
`name`	Specifies the name of the generated Java enum type. This value must be a valid Java identifier.
`map`	Specifies if the enumeration should be mapped to a Java enum type. The default value is `true`.

Member customizer

The `jaxb:typesafeEnumMember` element specifies the mapping between an XML Schema `enumeration` facet and a Java enum type constant. You must use one for each `enumeration` facet in the enumeration whose mapping is being customized.

When using in-line customization, this element can be used in one of two ways:

- You can place it inside the `xsd:annotation` element of the `enumeration` facet it is modifying.
- You can place all of them as children of the `jaxb:typesafeEnumClass` element used to customize the enumeration.

The `jaxb:typesafeEnumMember` element has a `name` attribute that is required. The `name` attribute specifies the name of the generated Java enum type constant. It's value must be a valid Java identifier.

This element also has a `value` attribute. The `value` is used to associate the `enumeration` facet with the proper `jaxb:typesafeEnumMember` element. The value of the `value` attribute must match one of the values of an `enumeration` facets' `value` attribute. This attribute is required when you use an external binding specification for customizing the type generation or when you group the `jaxb:typesafeEnumMember` elements as children of the `jaxb:typesafeEnumClass` element.

Examples

Example 139 on page 223 shows an enumerated type that used in-line customization and has the enumeration's members customized separately.

Example 139. In-line Customization of an Enumerated Type

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <simpleType name="widgetInteger">
    <annotation>
      <appinfo>
        <jaxb:typesafeEnumClass />
      </appinfo>
    </annotation>
    <restriction base="xsd:int">
      <enumeration value="1">
        <annotation>
          <appinfo>
            <jaxb:typesafeEnumMember name="one" />
          </appinfo>
        </annotation>
      </enumeration>
      <enumeration value="2">
```

```
        <annotation>
          <appinfo>
            <jaxb:typesafeEnumMember name="two" />
          </appinfo>
        </annotation>
      </enumeration>
      <enumeration value="3">
        <annotation>
          <appinfo>
            <jaxb:typesafeEnumMember name="three" />
          </appinfo>
        </annotation>
      </enumeration>
      <enumeration value="4">
        <annotation>
          <appinfo>
            <jaxb:typesafeEnumMember name="four" />
          </appinfo>
        </annotation>
      </enumeration>
    </restriction>
  </simpleType>
<schema>
```

Example 140 on page 224 shows an enumerated type that used in-line customization and combines the member's customization in the class customization.

Example 140. In-line Customization of an Enumerated Type Using a Combined Mapping

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <simpleType name="widgetInteger">
    <annotation>
      <appinfo>
        <jaxb:typesafeEnumClass>
            <jaxb:typesafeEnumMember value="1" name="one" />
            <jaxb:typesafeEnumMember value="2" name="two" />
            <jaxb:typesafeEnumMember value="3" name="three" />
            <jaxb:typesafeEnumMember value="4" name="four" />
        </jaxb:typesafeEnumClass>
      </appinfo>
    </annotation>
    <restriction base="xsd:int">
      <enumeration value="1" />
      <enumeration value="2" />
      <enumeration value="3" />
      <enumeration value="4" >
    </restriction>
  </simpleType>
<schema>
```

Example 141 on page 225 shows en external binding file to customize an enumerated type.

Example 141. Binding File for Customizing an Enumeration

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings schemaLocation="enumMap.xsd">
    <jaxb:bindings node="xsd:simpleType[@name='widgetInteger']">
        <jaxb:typesafeEnumClass>
            <jaxb:typesafeEnumMember value="1" name="one" />
            <jaxb:typesafeEnumMember value="2" name="two" />
            <jaxb:typesafeEnumMember value="3" name="three" />
            <jaxb:typesafeEnumMember value="4" name="four" />
        </jaxb:typesafeEnumClass>
    </jaxb:bindings>
  </jaxb:bindings>
<jaxb:bindings>
```

Customizing Fixed Value Attribute Mapping

Overview

By default the code generators map attributes defined as having a fixed value to normal properties. When using schema validation, Artix ESB can enforce the schema definition, however that results in a performance impact.

Another way to map attributes that have fixed values to Java is to map them to Java constants. You can instruct the code generator to map fixed value attributes to Java constants using the `globalBindings` customization element. You can also customize the mapping of fixed value attributes to Java constants at a more localized level using the `property` element.

Global customization

You can alter this behavior by adding the `globalBinding` element's `fixedAttributeAsConstantProperty` attribute. Setting this attribute to `true` instructs the code generator to map any attribute defined using `fixed` attribute to a Java constant.

Example 142 on page 226 shows an in-line customization to force the code generator to generate constants for attributes with fixed values.

Example 142. In-Line Customization to Force Generation of Constants

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <annotation>
    <appinfo>
      <jaxb:globalBindings fixedAttributeAsConstantProperty="true" />
    </appinfo>
  </annotation>
  ...
</schema>
```

Example 143 on page 226 shows en external binding file to customize generation of fixed attributes.

Example 143. Binding File to Force Generation of Constants

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
```

```
  <jaxb:bindings schemaLocation="types.xsd">
    <jaxb:globalBindings fixedAttributeAsConstantProperty="true" />
  <jaxb:bindings>
<jaxb:bindings>
```

Local mapping

You can customize attribute mapping on a per-attribute basis using the `property` element's `fixedAttributeAsConstantProperty` attribute. Setting this attribute to `true` instructs the code generator to map any attribute defined using `fixed` attribute to a Java constant.

Example 144 on page 227 shows an in-line customization to force the code generator to generate constants for a single attribute with a fixed value.

Example 144. In-Line Customization to Force Generation of Constants

```
<schema targetNamespace="http://widget.com/types/widgetTypes"
        xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
        xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
        jaxb:version="2.0">
  <complexType name="widgetAttr">
    <sequence>
      ...
    </sequence>
    <attribute name="fixer" type="xsd:int" fixed="7">
      <annotation>
        <appinfo>
          <jaxb:property fixedAttributeAsConstantProperty="true" />
        </appinfo>
      </annotation>
     </attribute>
  </complexType>
  ...
</schema>
```

Example 145 on page 227 shows en external binding file to customize generation of a fixed attribute.

Example 145. Binding File to Force Generation of Constants

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings schemaLocation="types.xsd">
    <jaxb:bindings node="xsd:complexType[@name='widgetAttr']">
      <jaxb:bindings node="xsd:attribute[@name='fixer']">
```

```
            <jaxb:property fixedAttributeAsConstantProperty="true" />
        </jaxb:bindings>
    </jaxb:bindings>
  </jaxb:bindings>
<jaxb:bindings>
```

Java mapping

In the defalt mapping all attributes are mapped to standard Java properties with getter and setter methods. When you apply this customization to an attribute defined using the `fixed` attribute, the attribute is mapped to a Java constant as shown in Example 146 on page 228.

Example 146. Mapping of a Fixed Value Attribute to a Java Constant

```
@XmlAttribute
public final static type NAME = value;
```

`type` is determined using by mapping the base type of the attribute to a Java type using the mappings described in Primitive Types on page 122.

`NAME` is determined by converting the value of the `attribute` element's `name` attribute to all capital letters.

`value` is determined by the value of the `attribute` element's `fixed` attribute.

For example, the attribute defined in Example 144 on page 227 would be mapped as shown in Example 147 on page 228.

Example 147. Fixed Value Attribute Mapped to a Java Constant

```
@XmlRootElement(name = "widgetAttr")
public class WidgetAttr {

    ...

  @XmlAttribute
  public final static int FIXER = 7;

  ...

}
```

Specifying the Base Type of an Element or an Attribute

Overview

You occasionally need to customize the class of the object generated for an element or an attribute defined as part of an XML Schema complex type. For example, you may want to use a more generalized class of object to allow for simple type substitution.

One way of doing this is to use the JAXB base type customization. It allows you to, on a case by case basis, specify the class of object generated for an element or an attribute. The base type customization allows you to specify an alternate mapping between the XML Schema construct and the generated Java object. This alternate mapping can be a simple specialization or generalization of the default base class. It can also be a mapping of an XML Schema primitive type to a Java class.

Customization usage

You apply the JAXB base type property to an XML Schema construct using the JAXB `baseType` customization element. The `baseType` customization element is a child of the JAXB `property` element, so it must be properly nested.

Depending on how you want to customize the mapping of the XML Schema construct to Java object, you would add either the `baseType` customization element's `name` attribute or a `javaType` child element. The `name` attribute is used to map the default class of the generated object to another class within the same class hierarchy. The `javaType` element is used when you want to map XML Schema primitive types to a Java class.

Important

You cannot use both the `name` attribute and a `javaType` child element in the same `baseType` customization element.

Specializing or generalizing the default mapping

The `baseType` customization element's `name` attribute is used to redefine the class of the generated object to a class within the same Java class hierarchy. The attribute specifies the fully qualified name of the Java class to which the XML Schema construct will be mapped. The specified Java class **must** be either a super-class or a sub-class of the java class that the code generator would normally generate for the XML Schema construct. For XML Schema primitive types that map to Java primitive types, the wrapper class is used as the default base class for the purposes of customization.

For example, an element defined as being of xsd:int would use `java.lang.Integer` as its default base class. The value of the `name` attribute could specify any super-class of `Integer` such as `Number` or `Object`.

Tip

For simple type substitution, the most common customization is to map the primitive types to an `Object` object.

Example 148 on page 230 shows an in-line customization that maps one element in a complex type to a Java `Object` object.

Example 148. In-Line Customization of a Base Type

```
<complexType name="widgetOrderInfo">
  <all>
    <element name="amount" type="xsd:int" />
     <element name="shippingAdress" type="Address>
      <annotation>
        <appinfo>
           <jaxb:property>
             <jaxb:baseType name="java.lang.Object" />
           </jaxb:property>
        </appinfo>
      </annotation>
    </element>
    <element name="type" type="xsd:string"/>
  </all>
</complexType>
```

Example 149 on page 230 shows an external binding file for the customization shown in Example 148 on page 230.

Example 149. External Binding File to Customize a Base Type

```
<jaxb:bindings xmlns:jaxb="http://java.sun.com/xml/ns/jaxb"
               xmlns:xsd="http://www.w3.org/2001/XMLSchema"
               jaxb:version="2.0">
  <jaxb:bindings schemaLocation="enumMap.xsd">
    <jaxb:bindings node="xsd:ComplexType[@name='widgetOrderInfo']">
      <jaxb:bindings node="xsd:element[@name='shippingAddress']">
        <jaxb:property>
          <jaxb:baseType name="java.lang.Object" />
        </jaxb:property>
      </jaxb:bindings>
    </jaxb:bindings>
  </jaxb:bindings>
<jaxb:bindings>
```

The resulting Java object's `@XmlElement` annotation will include a type property. The value of the type property is the class object representing the generated object's default base type. In the case of XML Schema primitive types, the class will be the wrapper class of the corresponding Java primitive type.

Example 150 on page 231 shows the class generated based on the schema definition in Example 149 on page 230.

Example 150. Java Class with a Modified Base Class

```
public class WidgetOrderInfo {

    protected int amount;
    @XmlElement(required = true)
    protected String type;
    @XmlElement(required = true, type = Address.class)
    protected Object shippingAddress;

    ...
    public Object getShippingAddress() {
        return shippingAddress;
    }


    public void setShippingAddress(Object value) {
        this.shippingAddress = value;
    }

}
```

Usage with javaType

The `javaType` element can be used to customize how elements and attributes of XML Schema primitive types are mapped to Java objects. Using the `javaType` element provides you with a lot more flexibility than simply using the `baseType` element's `name` attribute. The `javaType` element allows you to map a primitive type to any class of object.

For a detailed description of using the `javaType` element see Specifying the Java Class of an XML Schema Primitive on page 211.

Part III. Advanced Programming Tasks

The JAX-WS programming model offers a number of advanced features.

Developing Asynchronous Applications

JAX-WS provides an easy mechanism for accessing services asynchronously. The SEI can specify additional methods that a can use to access a service asynchronously. The Artix ESB code generators will generate the extra methods for you. You simply need to add the business logic.

In addition to the usual synchronous mode of invocation, Artix ESB also supports two forms of asynchronous invocation:

- Polling approach

  In this case, to invoke the remote operation, you call a special method that has no output parameters, but returns a `javax.xml.ws.Response` object. The `Response` object (which inherits from the `javax.util.concurrency.Future` interface) can be polled to check whether or not a response message has arrived.

- Callback approach

  In this case, to invoke the remote operation, you call another special method that takes a reference to a callback object (of `javax.xml.ws.AsyncHandler` type) as one of its parameters. Whenever the response message arrives at the client, the runtime calls back on the `AsyncHandler` object to give it the contents of the response message.

WSDL for Asynchronous Examples

Example 151 on page 238 shows the WSDL contract that is used for the asynchronous examples. The contract defines a single interface, `GreeterAsync`, which contains a single operation, greetMeSometime.

Example 151. WSDL Contract for Asynchronous Example

```
<?xml version="1.0" encoding="UTF-8"?><wsdl:definitions xmlns="http://schem
as.xmlsoap.org/wsdl/"
                  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
                  xmlns:tns="http://apache.org/hello_world_async_soap_http"
                  xmlns:x1="http://apache.org/hello_world_async_soap_http/types"
                  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                  targetNamespace="http://apache.org/hello_world_async_soap_http"
                  name="HelloWorld">
  <wsdl:types>
    <schema targetNamespace="http://apache.org/hello_world_async_soap_http/types"
            xmlns="http://www.w3.org/2001/XMLSchema"
            xmlns:x1="http://apache.org/hello_world_async_soap_http/types"
            elementFormDefault="qualified">
      <element name="greetMeSometime">
        <complexType>
          <sequence>
            <element name="requestType" type="xsd:string"/>
          </sequence>
        </complexType>
      </element>
      <element name="greetMeSometimeResponse">
        <complexType>
          <sequence>
            <element name="responseType"
                     type="xsd:string"/>
          </sequence>
        </complexType>
      </element>
    </schema>
  </wsdl:types>

  <wsdl:message name="greetMeSometimeRequest">
    <wsdl:part name="in" element="x1:greetMeSometime"/>
  </wsdl:message>
  <wsdl:message name="greetMeSometimeResponse">
    <wsdl:part name="out"
               element="x1:greetMeSometimeResponse"/>
  </wsdl:message>
  <wsdl:portType name="GreeterAsync">
    <wsdl:operation name="greetMeSometime">
      <wsdl:input name="greetMeSometimeRequest"
                  message="tns:greetMeSometimeRequest"/>
      <wsdl:output name="greetMeSometimeResponse"
                   message="tns:greetMeSometimeResponse"/>
    </wsdl:operation>
  </wsdl:portType>

  <wsdl:binding name="GreeterAsync_SOAPBinding"
                type="tns:GreeterAsync">
    ...
  </wsdl:binding>

  <wsdl:service name="SOAPService">
    <wsdl:port name="SoapPort"
               binding="tns:GreeterAsync_SOAPBinding">
      <soap:address location="http://localhost:9000/SoapContext/SoapPort"/>
    </wsdl:port>
  </wsdl:service>
</wsdl:definitions>
```

Generating the Stub Code

The asynchronous style of invocation requires extra stub code for the dedicated asynchronous methods defined on the SEI. This special stub code is not generated by default, however. To switch on the asynchronous feature and generate the requisite stub code, you must use the mapping customization feature from the WSDL 2.0 specification.

Defining the customization

Customization enables you to modify the way the **artix wsdl2java** generates stub code. In particular, it enables you to modify the WSDL-to-Java mapping and to switch on certain features. Here, customization is used to switch on the asynchronous invocation feature. Customizations are specified using a binding declaration, which you define using a `jaxws:bindings` tag (where the jaxws prefix is tied to the `http://java.sun.com/xml/ns/jaxws` namespace). There are two alternative ways of specifying a binding declaration:

- External binding declaration — the `jaxws:bindings` element is defined in a file separately from the WSDL contract. You specify the location of the binding declaration file to **artix wsdl2java** when you generate the stub code.
- Embedded binding declaration — you can also embed the `jaxws:bindings` element directly in a WSDL contract, treating it as a WSDL extension. In this case, the settings in `jaxws:bindings` apply only to the immediate parent element.

This section considers only the external binding declaration. The template for a binding declaration file that switches on asynchronous invocations is shown in Example 152 on page 240.

Example 152. Template for an Asynchronous Binding Declaration

```
<bindings xmlns:xsd="http://www.w3.org/2001/XMLSchema"
          xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
          wsdlLocation="AffectedWSDL"
          xmlns="http://java.sun.com/xml/ns/jaxws">
  <bindings node="AffectedNode">
    <enableAsyncMapping>true</enableAsyncMapping>
  </bindings>
</bindings>
```

Where *`AffectedWSDL`* specifies the URL of the WSDL contract that is affected by this binding declaration. The *`AffectedNode`* is an XPath value that specifies which node (or nodes) from the WSDL contract are affected by this binding declaration. You can set *AffectedNode* to `wsdl:definitions`, if you want the entire WSDL contract to be affected. The `jaxws:enableAsyncMapping` element is set to `true` to enable the asynchronous invocation feature.

For example, if you want to generate asynchronous methods only for the `GreeterAsync` interface, you could specify <bindings node="wsdl:definitions/wsdl:portType[@name='GreeterAsync']"> in the preceding binding declaration.

Running the code generator

Assuming that the binding declaration is stored in a file, `async_binding.xml`, you can generate the requisite stub files with asynchronous support by entering the following command:

```
artix wsdl2java -ant -client -d ClientDir -b async_binding.xml
hello_world.wsdl
```

When you run **artix wsdl2java**, you specify the location of the binding declaration file using the `-b` option.

Generated code

After generating the stub code in this way, the `GreeterAsync` SEI (in the file `GreeterAsync.java`) is defined as shown in Example 153 on page 241.

Example 153. Service Endpoint Interface with Methods for Asynchronous Invocations

```
/* Generated by WSDLToJava Compiler. */
package org.apache.hello_world_async_soap_http;

import org.apache.hello_world_async_soap_http.types.GreetMeSometimeResponse;
...

public interface GreeterAsync
{
  public Future<?> greetMeSometimeAsync(
        java.lang.String requestType,
        AsyncHandler<GreetMeSometimeResponse> asyncHandler
    );

    public Response<GreetMeSometimeResponse> greetMeSometimeAsync(
        java.lang.String requestType
    );

    public java.lang.String greetMeSometime(
        java.lang.String requestType
    );
}
```

In addition to the usual synchronous method, `greetMeSometime()`, two asynchronous methods are also generated for the greetMeSometime operation:

-
  ```
  public Future<?> greetMeSomtimeAsync(java.lang.String requestType,
                                       AsyncHandler<GreetMeSomtimeResp
  ```

  Call this method for the callback approach to asynchronous invocation.

-
  ```
  public Response<GreetMeSomeTimeResponse> greetMeSometimeAsync(java.l
  ```

  Call this method for the polling approach to asynchronous invocation.

Implementing an Asynchronous Client with the Polling Approach

The polling approach is the more straightforward of the two approaches to developing an asynchronous application. The client invokes the asynchronous method called `OperationNameAsync()` and is returned a `Response<T>` object that it can poll for a response. What the client does while it is waiting for a response is up to the requirements of the application. There are two basic patterns for how to handle the polling:

- Non-blocking polling

  You periodically check to see if the result is ready by calling the non-blocking `Response<T>.isDone()` method. If the result is ready, the client can process it. If it not, the client can continue doing other things.

- Blocking polling

  You call `Response<T>.get()` right away and block until the response arrives (optionally specifying a timeout).

Using the non-blocking pattern

Example 154 on page 243 illustrates using non-blocking polling to make an asynchronous invocation on the greetMeSometime operation defined in Example 151 on page 238. The client invokes the asynchronous operation and periodically checks to see if the result has returned.

Example 154. Non-Blocking Polling Approach for an Asynchronous Operation Call

```
package demo.hw.client;

import java.io.File;
import java.util.concurrent.Future;

import javax.xml.namespace.QName;
import javax.xml.ws.Response;

import org.apache.hello_world_async_soap_http.*;

public final class Client {
  private static final QName SERVICE_NAME
    = new QName("http://apache.org/hello_world_async_soap_http",
                "SOAPService");
  private Client() {}

  public static void main(String args[]) throws Exception {

    // set up the proxy for the client

❶     Response<GreetMeSometimeResponse> greetMeSomeTimeResp =
      port.greetMeSometimeAsync(System.getProperty("user.name"));

❷       while (!greetMeSomeTimeResp.isDone()) {
      // client does some work
      }
❸       GreetMeSometimeResponse reply = greetMeSomeTimeResp.get();
      // process the response

      System.exit(0);
  }
}
```

The code in Example 154 on page 243 does the following:

❶ Invokes the `greetMeSometimeAsync()` on the proxy.

The method call returns the `Response<GreetMeSometimeResponse>` object to the client immediately. The Artix ESB runtime handles the details of receiving the reply from the remote endpoint and populating the `Response<GreetMeSometimeResponse>` object.

Note

The runtime transmits the request to the remote endpoint's `greetMeSometime()` method and handles the details of the asynchronous nature of the call under the covers. The endpoint, and therefore the service implementation, never needs to worry about the details of how the client intends to wait for a response.

❷ Checks to see if a response has arrived by checking the `isDone()` of the returned `Response` object.

If the response has not arrived, the client does some work before checking again.

❸ If the response has arrived, the client retrieves it from the `Response` object using the `get()`.

Using the blocking pattern

Using blocking polling to make asynchronous invocations on a remote operation follows the same steps as non-blocking polling. However, instead of using the `Response` object's `isDone()` to check if a response has been returned before calling the `get()` to retrieve the response, you immediately call the `get()`. The `get()` blocks until the response is available.

Tip

You can also pass a timeout limit to the `get()` method.

Example 155 on page 245 shows a client that uses blocking polling.

Example 155. Blocking Polling Approach for an Asynchronous Operation Call

```
package demo.hw.client;

import java.io.File;
import java.util.concurrent.Future;

import javax.xml.namespace.QName;
import javax.xml.ws.Response;

import org.apache.hello_world_async_soap_http.*;

public final class Client {
  private static final QName SERVICE_NAME
    = new QName("http://apache.org/hello_world_async_soap_http",
                "SOAPService");

  private Client() {}

  public static void main(String args[]) throws Exception {

    // set up the proxy for the client

    Response<GreetMeSometimeResponse> greetMeSomeTimeResp =
      port.greetMeSometimeAsync(System.getProperty("user.name"));
    GreetMeSometimeResponse reply = greetMeSomeTimeResp.get();
      // process the response
      System.exit(0);
  }
}
```

Implementing an Asynchronous Client with the Callback Approach

An alternative approach to making an asynchronous operation invocation is to implement a callback class. You then call the asynchronous remote method that takes the callback object as a parameter. The runtime returns the response to the callback object.

To implement an application that uses callbacks you need to do the following:

1. Create a callback class that implements the `AsyncHandler` interface.

   Note

   Your callback object can perform any amount of response processing required by your application.

2. Make remote invocations using the `*operationName*Async()` that takes the callback object as a parameter and returns a `Future<?>` object.

3. If your client needs to access the response data, you can periodically use the returned `Future<?>` object's `isDone()` method to see if the remote endpoint has sent the response.

   Tip

   If the callback object does all of the response processing, you do not need to check if the response has arrived.

Implementing the callback

Your callback class must implement the `javax.xml.ws.AsyncHandler` interface. The interface defines a single method:

```
void handleResponse(Response<T> res);
```

The Artix ESB runtime calls the `handleResponse()` to notify the client that the response has arrived. Example 156 on page 247 shows an outline of the `AsyncHandler` interface that you need to implement.

Example 156. The `javax.xml.ws.AsyncHandler` Interface

```
public interface javax.xml.ws.AsyncHandler
{
  void handleResponse(Response<T> res)
}
```

Example 157 on page 247 shows a callback class for the greetMeSometime operation defined in Example 151 on page 238.

Example 157. Callback Implementation Class

```
package demo.hw.client;

import javax.xml.ws.AsyncHandler;
import javax.xml.ws.Response;

import org.apache.hello_world_async_soap_http.types.*;

public class GreeterAsyncHandler implements AsyncHandler<GreetMeSometimeResponse>
{
❶  private GreetMeSometimeResponse reply;

❷  public void handleResponse(Response<GreetMeSometimeResponse>
                              response)
  {
    try
    {
      reply = response.get();
    }
    catch (Exception ex)
    {
      ex.printStackTrace();
    }
  }

❸  public String getResponse()
  {
    return reply.getResponseType();
  }
}
```

The callback implementation shown in Example 157 on page 247 does the following:

❶ Defines a member variable, `response`, to hold the response returned from the remote endpoint.

❷ Implements `handleResponse()`.

This implementation simply extracts the response and assigns it to the member variable `reply`.

❸ Implements an added method called `getResponse()`.

This method is a convenience method that extracts the data from `reply` and returns it.

Implementing the consumer

Example 158 on page 248 illustrates a client that uses the callback approach to make an asynchronous call to the GreetMeSometime operation defined in Example 151 on page 238.

Example 158. Callback Approach for an Asynchronous Operation Call

```
package demo.hw.client;

import java.io.File;
import java.util.concurrent.Future;

import javax.xml.namespace.QName;
import javax.xml.ws.Response;

import org.apache.hello_world_async_soap_http.*;

public final class Client {
  ...

  public static void main(String args[]) throws Exception
  {
    ...
    // Callback approach
❶     GreeterAsyncHandler callback = new GreeterAsyncHandler();

❷     Future<?> response =
      port.greetMeSometimeAsync(System.getProperty("user.name"),
                                callback);
❸     while (!response.isDone())
    {
      // Do some work
    }
❹     resp = callback.getResponse();
    ...
    System.exit(0);
  }
}
```

The code in Example 158 on page 248 does the following:

❶ Instantiates a callback object.

❷ Invokes the `greetMeSometimeAsync()` that takes the callback object on the proxy.

The method call returns the `Future<?>` object to the client immediately. The Artix ESB runtime handles the details of receiving the reply from the remote endpoint, invoking the callback object's `handleResponse()` method, and populating the `Response<GreetMeSometimeResponse>` object.

Note

The runtime transmits the request to the remote endpoint's `greetMeSometime()` method and handles the details of the asynchronous nature of the call without the remote endpoint's knowledge. The endpoint, and therefore the service implementation, never needs to worry about the details of how the client intends to wait for a response.

❸ Uses the returned `Future<?>` object's `isDone()` method to check if the response has arrived from the remote endpoint.

❹ Invokes the callback object's `getResponse()` method to get the response data.

Using Raw XML Messages

The high-level JAX-WS APIs shield the developer from using native XML messages by marshelling the data into JAXB objects. However, there are cases when it is better to have direct access to the raw XML message data that is passing on the wire. The JAX-WS APIs provide two interfaces that provide access to the raw XML: `Dispatch` is the client-side interface. `Provider` is the server-side interface.

Using XML in a Consumer with the `Dispatch` Interface

The `Dispatch` interface is a low-level JAX-WS API that allows you work directly with raw messages. It accepts and returns messages, or payloads, of a number of types including DOM objects, SOAP messages, and JAXB objects. Because it is a low-level API, `Dispatch` does not perform any of the message preparation that the higher-level JAX-WS APIs perform. You must ensure that the messages, or payloads, that you pass to the `Dispatch` object are properly constructed and make sense for the remote operation being invoked.

Usage Modes

Overview

`Dispatch` objects have two *usage modes*:

- Message mode
- Message Payload mode (Payload mode)

The usage mode you specify for a `Dispatch` object determines the amount of detail is passed to the user level code.

Message mode

In *message mode*, a `Dispatch` object works with complete messages. A complete message includes any binding specific headers and wrappers. For example, a consumer interacting with a service that requires SOAP messages would need to provide the `Dispatch` object's `invoke()` method a fully specified SOAP message. The `invoke()` method will also return a fully specified SOAP message. The consumer code is responsible for completing and reading the SOAP message's headers and the SOAP message's envelope information.

Tip

Message mode is not ideal when you wish to work with JAXB objects.

You specify that a `Dispatch` object uses message mode by providing the value `java.xml.ws.Service.Mode.MESSAGE` when creating the `Dispatch` object. For more information about creating a `Dispatch` object see Creating a Dispatch object on page 258.

Payload mode

In *payload mode*, also called message payload mode, a `Dispatch` object works with only the payload of a message. For example, a `Dispatch` object working in payload mode works only with the body of a SOAP message. The binding layer processes any binding level wrappers and headers. When a result is returned from `invoke()` the binding level wrappers and headers are already striped away and only the body of the message is left.

Tip

When working with a binding that does not use special wrappers, such as the Artix ESB XML binding, payload mode and message mode provide the same results.

You specify that a `Dispatch` object uses payload mode by providing the value `java.xml.ws.Service.Mode.PAYLOAD` when creating the `Dispatch` object. For more information about creating a `Dispatch` object see Creating a Dispatch object on page 258.

Data Types

Overview

`Dispatch` objects, because they are low-level objects, are not optimized for using the same JAXB generated types as the higher level consumer APIs. `Dispatch` objects work with the following types of objects:

- `javax.xml.transform.Source`
- `javax.xml.soap.SOAPMessage`
- `javax.activation.DataSource`
- JAXB on page 256

Using Source objects

A `Dispatch` object can accept and return objects that are derived from the `javax.xml.transform.Source` interface. `Source` objects can be used with any binding and in either message or payload mode.

`Source` objects are low level objects that hold XML documents. Each `Source` implementation provides methods that access the stored XML documents and manipulate its contents. The following objects implement the `Source` interface:

`DOMSource`

Holds XML messages as a Document Object Model(DOM) tree. The XML message is stored as a set of `Node` objects that can be accessed using the `getNode()` method. Nodes can be updated or added to the DOM tree using the `setNode()` method.

`SAXSource`

Holds XML messages as a Simple API for XML (SAX) object. SAX objects contain an `InputSource` object that contains the raw data and an `XMLReader` object that parses the raw data.

`StreamSource`
: Holds XML messages as a data stream. The data stream can be manipulated as would any other data stream.

Using SOAPMessage objects

`Dispatch` objects can use `javax.xml.soap.SOAPMessage` objects when the following conditions are true:

- the `Dispatch` object is using the SOAP binding.
- the `Dispatch` object is using message mode.

A `SOAPMessage` object, as the name implies, holds a SOAP message. They contain one `SOAPPart` object and zero or more `AttachmentPart` objects. The `SOAPPart` object contains the SOAP specific portions of the SOAP message including the SOAP envelope, any SOAP headers, and the SOAP message body. The `AttachmentPart` objects contain binary data that was passed as an attachment.

Using DataSource objects

`Dispatch` objects can use objects that implement the `javax.activation.DataSource` interface when the following conditions are true:

- the `Dispatch` object is using the HTTP binding.
- the `Dispatch` object is using message mode.

`DataSource` objects provide a mechanism for working with MIME typed data from a variety of sources including URLs, files, and byte arrays.

Using JAXB objects

While `Dispatch` objects are intended to be low level API that allows you to work with raw messages, they also allow you to work with JAXB objects. To work with JAXB objects a `Dispatch` object must be passed a `JAXBContext` that knows how to marshal and unmarshal the JAXB objects in use. The `JAXBContext` is passed when the `Dispatch` object is created.

You can pass any JAXB object understood by the `JAXBContext` object as the parameter to the `invoke()` method. You can also cast the returned message into any JAXB object understood by the `JAXBContext` object.

Working with `Dispatch` Objects

Procedure

To use a `Dispatch` object to invoke a remote service you do the following:

1. Create a `Dispatch` object.
2. Construct a request message.
3. Call the proper `invoke()` method.
4. Parse the response message.

Creating a Dispatch object

To create a `Dispatch` object do the following:

1. Create a `Service` object to represent the `wsdl:service` element defining the service on which the `Dispatch` object will make invocations. See Creating a Service Object on page 47.
2. Create the `Dispatch` object using the `Service` object's `createDispatch()` method shown in Example 159 on page 258.

Example 159. The `createDispatch()` Method

```
public Dispatch<T> createDispatch(QName portName,
                                  java.lang.Class<T> type,
                                  Service.Mode mode)
  throws WebServiceException;
```

Note

If you are using JAXB objects the method signature for `createDispatch()` is:

```
public Dispatch<T> createDispatch(QName portName,
                                  javax.xml.bind.JAXBContex
                                  Service.Mode mode)
  throws WebServiceException;
```

Table 22 on page 259 describes the parameters for `createDispatch()`.

Table 22. Parameters for `createDispatch()`

Parameter	Description
portName	Specifies the QName of the `wsdl:port` element that represent the service provider on which the `Dispatch` object will make invocations.
type	Specifies the data type of the objects used by the `Dispatch` object. See Data Types on page 255. **Note** If you are working with JAXB objects, this parameter is where you would specify the `JAXBContext` object used to marshal and unmarshal the JAXB objects.
mode	Specifies the usage mode for the `Dispatch` object. See Usage Modes on page 253.

Example 160 on page 259 shows code for creating a `Dispatch` object that works with `DOMSource` objects in payload mode.

Example 160. Creating a `Dispatch` Object

```
package com.iona.demo;

import javax.xml.namespace.QName;
import javax.xml.ws.Service;

public class Client
{
public static void main(String args[])
  {
    QName serviceName = new QName("http://org.apache.cxf", "stockQuoteReporter");
    Service s = Service.create(serviceName);

    QName portName = new QName("http://org.apache.cxf", "stockQuoteReporterPort");
    Dispatch<DOMSource> dispatch = s.createDispatch(portName,
                                                  DOMSource.class,
                                                  Service.Mode.PAYLOAD);
    ...
```

Constructing request messages

When working with `Dispatch` objects requests must be built from scratch. The developer is responsible for ensuring that the messages passed to a

`Dispatch` object match a request that the targeted service provider can process. This requires precise knowledge about the messages used by the service provider and what, if any, header information it requires.

This information can be provided by a WSDL document or an XMLSchema document that defines the messages. While service providers vary greatly there are a few guidelines that can be followed:

- The root element of the request is based in the value of the `name` attribute of the `wsdl:operation` element that corresponds to the operation being invoked.

Warning

If the service being invoked uses doc/literal bare messages, the root element of the request will be based on the value of `name` attribute of the `wsdl:part` element refered to by the `wsdl:operation` element.

- The root element of the request will be namespace qualified.
- If the service being invoked uses rpc/literal messages, the top-level elements in the request will not be namespace qualified.

Important

The children of top-level elements may be namespace qualified. To be certain you will need to check their schema definitions.

- If the service being invoked uses rpc/literal messages, none of the top-level elements can be null.
- If the service being invoked uses doc/literal messages, the schema definition of the message determines if any of the elements are namespace qualified.

For more information about how services use XML messages see the WS-I Basic Profile [http://www.ws-i.org/Profiles/BasicProfile-1.0-2004-04-16.html].

Synchronous invocation

For consumers that make synchronous invocations that generate a response, you use the `Dispatch` object's `invoke()` method shown in Example 161 on page 261.

Example 161. The `Dispatch.invoke()` Method

```
T invoke(T msg)
  throws WebServiceException;
```

The type of both the response and the request passed to the `invoke()` method are determined when the `Dispatch` object is created. For example if you created a `Dispatch` object using `createDispatch(portName, SOAPMessage.class, Service.Mode.MESSAGE)` the response and the request would both be `SOAPMessage` objects.

Note

When using JAXB objects, the response and the request can be of any type the provided `JAXBContext` object can marshal and unmarshal. Also, the response and the request can be different JAXB objects.

Example 162 on page 261 shows code for making a synchronous invocation on a remote service using a `DOMSource` object.

Example 162. Making a Synchronous Invocation Using a `Dispatch` Object

```
// Creating a DOMSource Object for the request
DocumentBuilder db = DocumentBuilderFactory.newDocumentBuilder();
Document requestDoc = db.newDocument();
Element root = requestDoc.createElementNS("http://org.apache.cxf/stockExample",
                                          "getStockPrice");
root.setNodeValue("DOW");
DOMSource request = new DOMSource(requestDoc);
```

```
// Dispatch disp created previously
DOMSource response = disp.invoke(request);
```

Asynchronous invocation

`Dispatch` objects also support asynchronous invocations. As with the higher level asynchronous APIs discussed in *Developing Asynchronous Applications* on page 237, `Dispatch` objects can use both the polling approach and the callback approach.

When using the polling approach the `invokeAsync()` method returns a `Response<t>` object that can be periodically polled to see if the response has arrived. Example 163 on page 262 shows the signature of the method used to make an asynchronous invocation using the polling approach.

Example 163. The `Dispatch.invokeAsync()` Method for Polling

```
  Response <T> invokeAsync(T msg)
    throws WebServiceException;
```

For detailed information on using the polling approach for asynchronous invocations see Implementing an Asynchronous Client with the Polling Approach on page 243.

When using the callback approach the `invokeAsync()` method takes an `AsyncHandler` implementation that processes the response when it is returned. Example 164 on page 262 shows the signature of the method used to make an asynchronous invocation using the callback approach.

Example 164. The `Dispatch.invokeAsync()` Method Using a Callback

```
  Future<?> invokeAsync(T msg,
                        AsyncHandler<T> handler)
    throws WebServiceException;
```

For detailed information on using the callback approach for asynchronous invocations see Implementing an Asynchronous Client with the Callback Approach on page 246.

Note

As with the synchronous `invoke()` method, the type of the response and the type of the request are determined when you create the `Dispatch` object.

Oneway invocation

When a request does not generate a response, you make remote invocations using the `Dispatch` object's `invokeOneWay()`. Example 165 on page 263 shows the signature for this method.

Example 165. The `Dispatch.invokeOneWay()` Method

```
void invokeOneWay(T msg)
  throws WebServiceException;
```

The type of object used to package the request is determined when the `Dispatch` object is created. For example if the `Dispatch` object is created using `createDispatch(portName, DOMSource.class, Service.Mode.PAYLOAD)` the request would be packaged into a `DOMSource` object.

Note

When using JAXB objects, the response and the request can be of any type the provided `JAXBContext` object can marshal and unmarshal. Also, the response and the request can be different JAXB objects.

Example 166 on page 263 shows code for making a oneway invocation on a remote service using a JAXB object.

Example 166. Making a One Way Invocation Using a `Dispatch` Object

```
// Creating a JAXBContext and an Unmarshaller for the request
JAXBContext jbc = JAXBContext.newInstance("org.apache.cxf.StockExample");
Unmarshaller u = jbc.createUnmarshaller();

// Read the request from disk
File rf = new File("request.xml");
GetStockPrice request = (GetStockPrice)u.unmarshal(rf);
```

```
// Dispatch disp created previously
disp.invokeOneWay(request);
```

Using XML in a Service Provider with the `Provider` Interface

The `Provider` interface is a low-level JAX-WS API that allows you to implement a service provider that works directly with messages as raw XML. The messages are not packaged into JAXB objects before being passed to an object that implements the `Provider` interface as they are with the higher level SEI based objects.

Messaging Modes

Overview

Objects that implement the `Provider` interface have two *messaging modes*:

- Message mode
- Payload mode

The messaging mode you specify determines the level of messaging detail that is passed to your implementation.

Message mode

When using *message mode*, a `Provider` implementation works with complete messages. A complete message includes any binding specific headers and wrappers. For example, a `Provider` implementation that uses a SOAP binding would receive requests as fully specified SOAP message. Any response returned from the implementation would also need to be a fully specified SOAP message.

You specify that a `Provider` implementation uses message mode by providing the value `java.xml.ws.Service.Mode.MESSAGE` as the value to the `javax.xml.ws.ServiceMode` annotation as shown in Example 167 on page 266.

Example 167. Specifying that a `Provider` Implementation Uses Message Mode

```
@WebServiceProvider
@ServiceMode(value=Service.Mode.MESSAGE)
public class stockQuoteProvider implements Provider<SOAPMes
sage>
{
  ...
}
```

Payload mode

In *payload mode* a `Provider` implementation works with only the payload of a message. For example, a `Provider` implementation working in payload mode works only with the body of a SOAP message. The binding layer processes any binding level wrappers and headers.

Tip

When working with a binding that does not use special wrappers, such as the Artix ESB XML binding, payload mode and message mode provide the same results.

You specify that a `Provider` implementation uses payload mode by providing the value `java.xml.ws.Service.Mode.PAYLOAD` as the value to the `javax.xml.ws.ServiceMode` annotation as shown in Example 168 on page 267.

Example 168. Specifying that a `Provider` Implementation Uses Payload Mode

```
@WebServiceProvider
@ServiceMode(value=Service.Mode.PAYLOAD)
public class stockQuoteProvider implements Provider<DOMSource>
{
  ...
}
```

Tip

If you do not provide the `@ServiceMode` annotation, the `Provider` implementation will default to using payload mode.

Data Types

Overview

`Provider` implementations, because they are low-level objects, cannot use the same JAXB generated types as the higher level consumer APIs. `Provider` implementations work with the following types of objects:

- `javax.xml.transform.Source`
- `javax.xml.soap.SOAPMessage`
- `javax.activation.DataSource`

Using Source objects

A `Provider` implementation can accept and return objects that are derived from the `javax.xml.transform.Source` interface. `Source` objects are low level objects that hold XML documents. Each `Source` implementation provides methods that access the stored XML documents and manipulate its contents. The following objects implement the `Source` interface:

`DOMSource`

Holds XML messages as a Document Object Model(DOM) tree. The XML message is stored as a set of `Node` objects that can be accessed using the `getNode()` method. Nodes can be updated or added to the DOM tree using the `setNode()` method.

`SAXSource`

Holds XML messages as a Simple API for XML (SAX) object. SAX objects contain an `InputSource` object that contains the raw data and an `XMLReader` object that parses the raw data.

`StreamSource`

Holds XML messages as a data stream. The data stream can be manipulated as would any other data stream.

Important

When using `Source` objects the developer is responsible for ensuring that all required binding specific wrappers are added to the message. For example, when interacting with a service expecting SOAP messages, the developer must ensure that the required SOAP envelope is added to the outgoing request and that the SOAP envelope's contents are correct.

Using SOAPMessage objects

`Provider` implementations can use `javax.xml.soap.SOAPMessage` objects when the following conditions are true:

- the `Provider` implementation is using the SOAP binding.
- the `Provider` implementation is using message mode.

A `SOAPMessage` object, as the name implies, holds a SOAP message. They contain one `SOAPPart` object and zero or more `AttachmentPart` objects. The `SOAPPart` object contains the SOAP specific portions of the SOAP message including the SOAP envelope, any SOAP headers, and the SOAP message body. The `AttachmentPart` objects contain binary data that was passed as an attachment.

Using DataSource objects

`Provider` implementations can use objects that implement the `javax.activation.DataSource` interface when the following conditions are true:

- the implementation is using the HTTP binding.
- the implementation is using message mode.

`DataSource` objects provide a mechanism for working with MIME typed data from a variety of sources including URLs, files, and byte arrays.

Implementing a `Provider` Object

Overview

The `Provider` interface is relatively easy to implement. It only has one method, `invoke()`, that needs to be implemented. In addition it has three simple requirements:

- An implementation must have the `@WebServiceProvider` annotation.
- An implementation must have a default public constructor.
- An implementation must implement a typed version of the `Provider` interface.

  In other words, you cannot implement a `Provider<T>` interface. You must implement a version of the interface that uses a concrete data type as listed in Data Types on page 268. For example, you can implement an instance of a `Provider<SAXSource>`.

The complexity of implementing the `Provider` interface surrounds handling the request messages and building the proper responses.

Working with messages

Unlike the higher-level SEI based service implementations, `Provider` implementations receive requests as raw XML data and must send responses as raw XML data. This requires that the developer has intimate knowledge of the messages used by the service being implemented. These details can typically be found in the WSDL document describing the service.

WS-I Basic Profile [http://www.ws-i.org/Profiles/BasicProfile-1.0-2004-04-16.html] provides guidelines about the messages used by services including:

- The root element of a request is based in the value of the `name` attribute of the `wsdl:operation` element that corresponds to the operation being invoked.

Warning

If the service uses doc/literal bare messages, the root element of the request will be based on the value of `name` attribute of the `wsdl:part` element referred to by the `wsdl:operation` element.

- The root element of all messages will be namespace qualified.
- If the service uses rpc/literal messages, the top-level elements in the messages will not be namespace qualified.

Important

The children of top-level elements may be namespace qualified. To be certain you will need to check their schema definitions.

- If the service uses rpc/literal messages, none of the top-level elements can be null.
- If the service uses doc/literal messages, the schema definition of the message determines if any of the elements are namespace qualified.

The @WebServiceProvider annotation

To be recognized by JAX-WS as a service implementation, a `Provider` implementation must be decorated with the `@WebServiceProvider` annotation.

Table 23 on page 271 describes the properties you can set for the `@WebServiceProvider` annotation.

Table 23. `@WebServiceProvider` Properties

Property	Description
portName	Specifies the value of `name` attribute of the `wsdl:port` element that defines the service's endpoint.
serviceName	Specifies the value of `name` attribute of the `wsdl:service` element that contains the service's endpoint.
targetNamespace	Specifies the targetname space fop the service's WSDL definition.

Property	Description
wsdlLocation	Specifies the URI for the WSDL document definig the service.

All of these properties are optional and are empty by default. If you leave them empty, Artix ESB will create values using information from the implementation class.

Implementing the invoke() method

The `Provider` interface has only one method, `invoke()`, that needs to be implemented. `invoke()` receives the incoming request packaged into the type of object declared by the type of `Provider` interface being implemented and returns the response message packaged into the same type of object. For example, an implementation of a `Provider<SOAPMessage>` interface would receive the request as a `SOAPMessage` object and return the response as a `SOAPMessage` object.

The messaging mode used by the `Provider` implementation determines the amount of binding specific information the request and response messages contain. Implementation using message mode receive all of the binding specific wrappers and headers along with the request. They must also add all of the binding specific wrappers and headers to the response message. Implementations using payload mode only receive the body of the request. The XML document returned by an implementation using payload mode will be placed into the body of the request message.

Examples

Example 169 on page 272 shows a `Provider` implementation that works with `SOAPMessage` objects in message mode.

Example 169. ***`Provider<SOAPMessage>`*** ***Implementation***

```
import javax.xml.ws.Provider;
import javax.xml.ws.Service;
import javax.xml.ws.ServiceMode;
import javax.xml.ws.WebServiceProvider;

❶@WebServiceProvider(portName="stockQuoteReporterPort"
                    serviceName="stockQuoteReporter")
❷@ServiceMode(value="Service.Mode.MESSAGE")
public class  stockQuoteReporterProvider implements Provider<SOAPMessage>
{
❸public stockQuoteReporterProvider()
  {
  }

❹public SOAPMessage invoke(SOAPMessage request)
  {
❺  SOAPBody requestBody = request.getSOAPBody();
❻  if(requestBody.getElementName.getLocalName.equals("getStockPrice"))
    {
❼    MessageFactory mf = MessageFactory.newInstance();
      SOAPFactory sf = SOAPFactory.newInstance();

❽    SOAPMessage response = mf.createMessage();
      SOAPBody respBody = response.getSOAPBody();
      Name bodyName = sf.createName("getStockPriceResponse");
      respBody.addBodyElement(bodyName);
      SOAPElement respContent = respBody.addChildElement("price");
      respContent.setValue("123.00");
      response.saveChanges();
❾    return response;
    }
    ...
  }
}
```

The code in Example 169 on page 272 does the following:

❶ Specifies that the following class implements a `Provider` object that implements the service whose `wsdl:service` element is named stockQuoteReporter and whose `wsdl:port` element is named stockQuoteReporterPort.

❷ Specifies that this `Provider` implementation uses message mode.

❸ Provides the required default public constructor.

❹ Provides an implementation of the `invoke()` method that takes a `SOAPMessage` object and returns a `SOAPMessage` object.

❺ Extracts the request message from the body of the incoming SOAP message.

❻ Checks the root element of the request message to determine how to process the request.

❼ Creates the factories needed for building the response.

❽ Builds the SOAP message for the response.

❾ Returns the response as a `SOAPMessage` object.

Example 170 on page 274 shows an example of a `Provider` implementation using `DOMSource` objects in payload mode.

Example 170. `Provider<DOMSource>` Implementation

```
import javax.xml.ws.Provider;
import javax.xml.ws.Service;
import javax.xml.ws.ServiceMode;
import javax.xml.ws.WebServiceProvider;

❶@WebServiceProvider(portName="stockQuoteReporterPort" servi
ceName="stockQuoteReporter")
❷@ServiceMode(value="Service.Mode.PAYLOAD")
public class  stockQuoteReporterProvider implements Pro
vider<DOMSource>
❸public stockQuoteReporterProvider()
  {
  }

❹public DOMSource invoke(DOMSource request)
  {
    DOMSource response = new DOMSource();
    ...
    return response;
  }
}
```

The code in Example 170 on page 274 does the following:

❶ Specifies that the class implements a `Provider` object that implements the service whose `wsdl:service` element is named stockQuoteReporter and whose `wsdl:port` element is named stockQuoteReporterPort.

❷ Specifies that this `Provider` implementation uses payload mode.

❸ Provides the required default public constructor.

❹ Provides an implementation of the `invoke()` method that takes a `DOMSource` object and returns a `DOMSource` object.

Working with Contexts

JAX-WS uses contexts to pass metadata along the messaging chain. This metadata, depending on its scope, is accessible to implementation level code. It is also accessible to JAX-WS handlers that operate on the message below the implementation level.

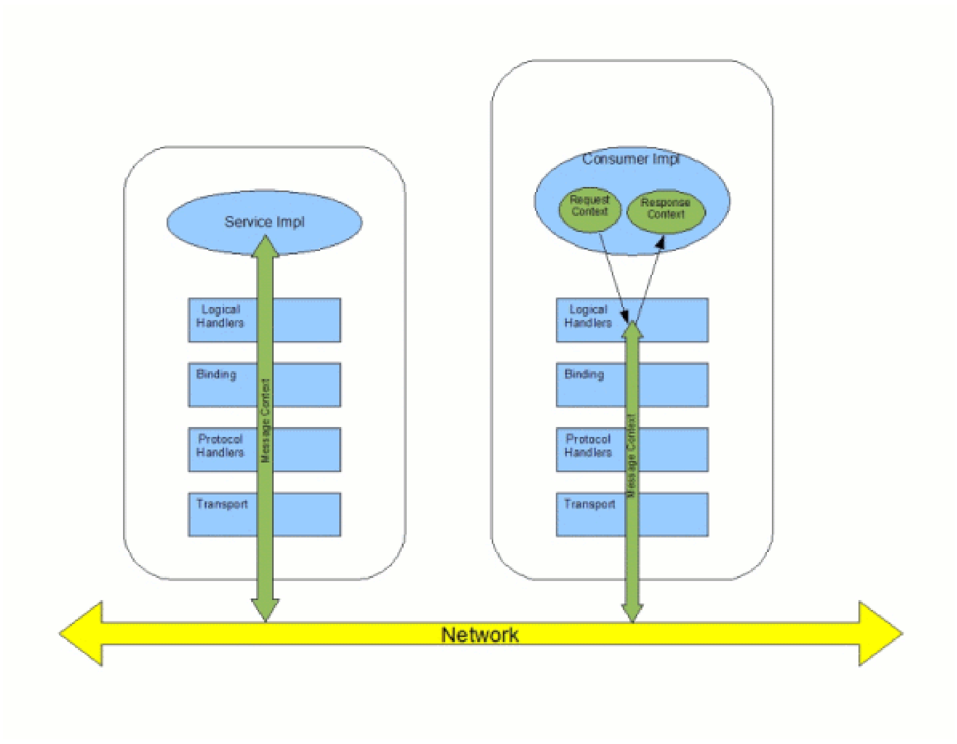
Understanding Contexts

In many instances it is necessary to pass information about a message to other parts of an application. Artix ESB does this using a context mechanism. Contexts are maps that hold properties relating to an outgoing or incoming message. The properties stored in the context are typically metadata about the message and the underlying transport used to communicate the message. For example, the transport specific headers used in transmitting the message, such as the HTTP response code or the JMS correlation ID, are stored in the JAX-WS contexts.

The contexts are available at all levels of a JAX-WS application. However, they differ in subtle ways depending upon where in the message processing stack you are accessing the context. JAX-WS `Handler` implementations have direct access to the contexts and can access all properties that are set in them. Service implementations access contexts by having them injected and can only access properties that are set in the `APPLICATION` scope. Consumer implementations can only access properties that are set in the `APPLICATION` scope.

Figure 1 on page 277 shows how the context properties pass through Artix ESB. As a message passes through the messaging chain, its associated message context passes along with it.

Figure 1. Message Contexts and Message Processing Path



How properties are stored in a context

The message contexts are all implementations of the `javax.xml.ws.handler.MessageContext` interface. The `MessageContext` interface extends the `java.util.Map<String key, Object value>` interface. `Map` objects store information as key value pairs.

In a message context, properties are stored as name value pairs. A property's key is a `String` that identifies the property. The value of a property can be any stored in any Java object. When the value is returned from a message context, the application must know the type to expect and cast accordingly. For example if a property's value is stored in a `UserInfo` object it will still be returned from a message context as a plain `Object` object that must be cast back into a `UserInfo` object.

Properties in a message context also have a scope. The scope determines where in the message processing chain a property can be accessed.

Property scopes

Properties in a message context are scoped. A property can have one of two scopes:

`APPLICATION`
: Properties scoped as `APPLICATION` are available to JAX-WS `Handler` implementations, consumer implementation code, and service provider implementation code. If a handler needed to pass a property to the service provider implementation, it would set the property's scope to `APPLICATION`. All properties set from either the consumer implementation or the service provider implementation contexts are automatically scoped as `APPLICATION`.

`HANDLER`
: Properties scoped as `HANDLER` are only available to JAX-WS `Handler` implementations. Properties stored in a message context from a `Handler` implementation are scoped as `HANDLER` by default.

You can change a property's scope using the message context's `setScope()` method. Example 171 on page 278 shows the method's signature.

Example 171. The `MessageContext.setScope()` Method

```
void setScope(String key,
              MessageContext.Scope scope)
  throws java.lang.IllegalArgumentException;
```

The first parameter specifies the property's key. The second specifies the new scope for the property. The scope can be either `MessageContext.Scope.APPLICATION` or `MessageContext.Scope.HANDLER`.

Overview contexts in Handler implementations

Classes that implement the JAX-WS `Handler` interface have direct access to a message's context information. The message's context information is passed into the `Handler` implementation's `handleMessage()`, `handleFault()`, and `close()` methods.

`Handler` implementations have access to all of the properties stored in the message context. In addition, logical handlers can access the contents of the message body through the message context.

Overview of contexts in service implementations

Service implementations can access properties scoped as `APPLICATION` from the message context. The service provider's implementation object accesses the message context through the `WebServiceContext` object.

For more information see Working with Contexts in a Service Implementation on page 280.

Overview of contexts in consumer implementations

Consumer implementations have indirect access to the contents of the message context. The consumer implementation has two separate message contexts. One, the request context, holds a copy of the properties used for outgoing requests. The other, the response context, holds a copy of the properties from an incoming response. The dispatch layer transfers the properties between the consumer implementation's message contexts and the message context used by the `Handler` implementations.

When a request is passed to the dispatch layer from the consumer implementation, the contents of the request context are copied into the message context used by the dispatch layer. When the response is returned from the service, the dispatch layer processes the message and sets the appropriate properties into its message context. After the dispatch layer processes a response, it copies all of the properties scoped as `APPLICATION` in its message context to the consumer implementation's response context.

For more information see Working with Contexts in a Consumer Implementation on page 287.

Working with Contexts in a Service Implementation

Overview

Context information is made available to service implementations using the `WebServiceContext` interface. From the `WebServiceContext` object you can obtain a `MessageContext` object that is populated with the current request's context properties that are in the application scope. You can manipulate the values of the properties and they are propagated back through the response chain.

Note

The `MessageContext` interface inherits from the `java.util.Map` interface. Its contents can be manipulated using the `Map` interface's methods.

Obtaining a context

To obtain the message context in a service implementation you need to do the following:

1. Declare a variable of type `WebServiceContext`.
2. Decorate the variable with the `javax.annotation.Resource` annotation to indicate that the context information is to be injected into the variable.
3. Obtain the `MessageContext` object from the `WebServiceContext` object using the `getMessageContext()` method.

   Important

   `getMessageContext()` can only be used in methods that are decorated with the `@WebMethod` annotation.

Example 172 on page 280 shows code for obtaining a context object.

Example 172. Obtaining a Context Object in a Service Implementation

```
import javax.xml.ws.*;
import javax.xml.ws.handler.*;
import javax.annotation.*;
```

```
@WebServiceProvider
public class WidgetServiceImpl
{
  @Resource
  WebServiceContext wsc;

  @WebMethod
  public String getColor(String itemNum)
  {
    MessageContext context = wsc.getMessageContext();
  }

  ...
}
```

Reading a property from a context

Once you have obtained the `MessageContext` object for your implementation, you can access the properties stored in it using the `get()` method shown in Example 173 on page 281.

Example 173. The `MessageContext.get()` Method

```
  V get(Object key);
```

Note

This `get()` is inherited from the `Map` interface.

The *`key`* parameter is the string representing the property you wish to retrieve from the context. The `get()` returns an object that must be cast to the proper type for the property. Table 24 on page 283 lists a number of the properties that are available in a service implementation's context.

Important

Changing the values of the object returned from the context will also change the value of the property in the context.

Example 174 on page 282 shows code for getting the name of the WSDL `operation` element that represents the invoked operation.

Example 174. Getting a Property from a Service's Message Context

```
import javax.xml.ws.handler.MessageContext;
import org.apache.cxf.message.Message;

  ...
  // MessageContext context retrieved in a previous example
  QName wsdl_operation = (QName)context.get(Message.WSDL_OPER
ATION);
```

Setting properties in a context

Once you have obtained the `MessageContext` object for your implementation, you can set properties, and change existing properties, using the `put()` method shown in Example 175 on page 282.

Example 175. The `MessageContext.put()` Method

```
V put(K key,
      V value)
  throws ClassCastException, IllegalArgumentException, NullPointerException;
```

If the property being set already exists in the message context, the `put()` method will replace the existing value with the new value and return the old value. If the property does not already exist in the message context, the `put()` method will set the property and return `null`.

Example 176 on page 282 shows code for setting the response code for an HTTP request.

Example 176. Setting a Property in a Service's Message Context

```
import javax.xml.ws.handler.MessageContext;
import org.apache.cxf.message.Message;

  ...
  // MessageContext context retrieved in a previous example
  context.put(Message.RESPONSE_CODE, new Integer(404));
```

Supported contexts

Table 24 on page 283 lists the properties accessible through the context in a service implementation object.

Table 24. Properties Available in the Service Implementation Context

Base Class	
Property Name	**Description**
`org.apache.cxf.message.Message`	
`PROTOCOL_HEADERS`[a]	Specifies the transport specific header information. The value is stored as a `java.util.Map<String, List<String>>`.
`RESPONSE_CODE`[a]	Specifies the response code returned to the consumer. The value is stored as a `Integer`.
`ENDPOINT_ADDRESS`	Specifies the address of the service provider. The value is stored as a `String`.
`HTTP_REQUEST_METHOD`[a]	Specifies the HTTP verb sent with a request. The value is stored as a `String`.
`PATH_INFO`[a]	Specifies the path of the resource being requested. The value is stored as a `String`. The path is the portion of the URI after the hostname and before any query string. For example, if an endpoint's URL is `http://cxf.apache.org/demo/widgets` the path would be `/demo/widgets`.
`QUERY_STRING`[a]	Specifies the query, if any, attached to the URI used to invoke the request. The value is strored as a `String`. Queries appear at the end of the URI after a `?`. For example, if a request was made to `http://cxf.apache.org/demo/widgets?color` the query would be `color`.
`MTOM_ENABLED`	Specifies whether or not the service provider can use MTOM for SOAP attachments. The value is stored as a `Boolean`.
`SCHEMA_VALIDATION_ENABLED`	Specifies whether or not the service provider validates messages against a schema. The value is stored as a `Boolean`.
`FAULT_STACKTRACE_ENABLED`	Specifies if the runtime will provide a stack trace along with a fault message. The value is stored as a `Boolean`.
`CONTENT_TYPE`	Specifies the MIME type of the message. The value is stored as a `String`.
`BASE_PATH`	Specifies the path of the resource being requested. The value is stored as a `java.net.URL`.

Base Class	
Property Name	**Description**
	The path is the portion of the URI after the hostname and before any query string. For example, if an endpoint's URL is `http://cxf.apache.org/demo/widgets` the path would be `/demo/widgets`.
`ENCODING`	Specifies the encoding of the message. The value is stored as a `String`.
`FIXED_PARAMETER_ORDER`	Specifies whether the parameters must appear in the message in a particular order. The value is stored as a `Boolean`.
`MAINTAIN_SESSION`	Specifies if the consumer wants to maintain the current session for future requests. The value is stored as a `Boolean`.
`WSDL_DESCRIPTION`[a]	Specifies the WSDL document defining the service being implemented. The value is stored as a `org.xml.sax.InputSource`.
`WSDL_SERVICE`[a]	Specifies the qualified name of the `wsdl:service` element defining the service being implemented. The value is stored as a `QName`.
`WSDL_PORT`[a]	Specifies the qualified name of the `wsdl:port` element defining the endpoint used to access the service. The value is stored as a `QName`.
`WSDL_INTERFACE`[a]	Specifies the qualified name of the `wsdl:portType` element defining the service being implemented. The value is stored as a `QName`.
`WSDL_OPERATION`[a]	Specifies the qualified name of the `wsdl:operation` element corresponding to the operation invoked by the consumer. The value is stored as a `QName`.
`javax.xml.ws.handler.MessageContext`	
`MESSAGE_OUTBOUND_PROPERTY`	Specifies if a message is outbound. The value is stored as a `Boolean`. `true` specifies that a message is outbound.
`INBOUND_MESSAGE_ATTACHMENTS`	Contains any attachments included in the request message. The value is stored as a `java.util.Map<String, DataHandler>`. The key value for the map is the MIME Content-ID for the header.
`OUTBOUND_MESSAGE_ATTACHMENTS`	Contains any attachments for the response message. The value is stored as a `java.util.Map<String, DataHandler>`. The key value for the map is the MIME Content-ID for the header.

Base Class	
Property Name	**Description**
`WSDL_DESCRIPTION`	Specifies the WSDL document defining the service being implemented. The value is stored as a `org.xml.sax.InputSource`.
`WSDL_SERVICE`	Specifies the qualified name of the `wsdl:service` element defining the service being implemented. The value is stored as a `QName`.
`WSDL_PORT`	Specifies the qualified name of the `wsdl:port` element defining the endpoint used to access the service. The value is stored as a `QName`.
`WSDL_INTERFACE`	Specifies the qualified name of the `wsdl:portType` element defining the service being implemented. The value is stored as a `QName`.
`WSDL_OPERATION`	Specifies the qualified name of the `wsdl:operation` element corresponding to the operation invoked by the consumer. The value is stored as a `QName`.
`HTTP_RESPONSE_CODE`	Specifies the response code returned to the consumer. The value is stored as a `Integer`.
`HTTP_REQUEST_HEADERS`	Specifies the HTTP headers on a request. The value is stored as a `java.util.Map<String, List<String>>`.
`HTTP_RESPONSE_HEADERS`	Specifies the HTTP headers for the response.The value is stored as a `java.util.Map<String, List<String>>`.
`HTTP_REQUEST_METHOD`	Specifies the HTTP verb sent with a request. The value is stored as a `String`.
`SERVLET_REQUEST`	Contains the servlet's request object. The value is stored as a `javax.servlet.http.HttpServletRequest`.
`SERVLET_RESPONSE`	Contains the servlet's response object. The value is stored as a `javax.servlet.http.HttpResponse`.
`SERVLET_CONTEXT`	Contains the servlet's context object. The value is stored as a `javax.servlet.ServletContext`.
`PATH_INFO`	Specifies the path of the resource being requested. The value is stored as a `String`. The path is the portion of the URI after the hostname and before any query string. For example, if an endpoint's URL is

Base Class	
Property Name	**Description**
	`http://cxf.apache.org/demo/widgets` the path would be `/demo/widgets`.
`QUERY_STRING`	Specifies the query, if any, attached to the URI used to invoke the request. The value is stored as a `String`. Queries appear at the end of the URI after a `?`. For example, if a request was made to `http://cxf.apache.org/demo/widgets?color` the query would be `color`.
`REFERENCE_PARAMETERS`	Specifies the WS-Addressing reference parameters. This includes all of the SOAP headers whose `wsa:IsReferenceParameter` attribute is set to `true`. The value is stored as a `java.util.List`.
`org.apache.cxf.transport.jms.JMSConstants`	
`JMS_SERVER_HEADERS`	Contains the JMS message headers. For more information see Working with JMS Message Properties on page 291.

[a]When using HTTP this property is the same as the standard JAX-WS defined property.

Working with Contexts in a Consumer Implementation

Overview

Consumer implementations have access to context information through the `BindingProvider` interface. The `BindingProvider` instance holds context information in two separate contexts:

request context

The *request context* enables you to set properties that affect outbound messages. Request context properties are applied to a specific port instance and, once set, the properties affect every subsequent operation invocation made on the port, until such time as a property is explicitly cleared. For example, you might use a request context property to set a connection timeout or to initialize data for sending in a header.

response context

The *response context* enables you to read the property values set by the inbound message from the last operation invocation from the current thread. Response context properties are reset after every operation invocation. For example, you might access a response context property to read header information received from the last inbound message.

Important

Only information that is placed in the application scope of a message context can be accessed by the consumer implementation.

Obtaining a context

Contexts are obtained using the `javax.xml.ws.BindingProvider` interface. The `BindingProvider` interface has two methods for obtaining a context:

`getRequestContext()`

The `getRequestContext()` method, shown in Example 177 on page 288, returns the request context as a `Map` object. The returned `Map` object can be used to directly manipulate the contents of the context.

Example 177. The `getRequestContext()` Method

```
Map<String, Object> getRequestContext();
```

`getResponseContext()`

The `getResponseContext()`, shown in Example 178 on page 288, returns the response context as a `Map` object. The returned `Map` object's contents reflect the state of the response context's contents from the most recent successful remote invocation in the current thread.

Example 178. The `getResponseContext()` Method

```
Map<String, Object> getResponseContext();
```

Since proxy objects implement the `BindingProvider` interface, a `BindingProvider` object can be obtained by casting the a proxy object. The contexts obtained from the `BindingProvider` object are only valid for operations invoked on the proxy object used to create it.

Example 179 on page 288 shows code for obtaining the request context for a proxy.

Example 179. Getting a Consumer's Request Context

```
// Proxy widgetProxy obtained previously
BindingProvider bp = (BindingProvider)widgetProxy
Map<String, Object> responseContext = bp.getResponseContext();
```

Reading a property from a context

Consumer contexts are stored in `java.util.Map<String, Object>` object. The maps have keys String and values of arbitrary type. Use `java.util.Map.get()` to access an entry in the hash map of response context properties.

To retrieve a particular context property, *`ContextPropertyName`*, use the code shown in Example 180 on page 289.

Example 180. Reading a Response Context Property

```
// Invoke an operation.
port.SomeOperation();

// Read response context property.
java.util.Map<String, Object> responseContext =
  ((javax.xml.ws.BindingProvider)port).getResponseContext();
PropertyType propValue = (PropertyType) responseContext.get(ContextPropertyName);
```

Setting properties in a context

Consumer contexts are hash maps stored in `java.util.Map<String, Object>` object. The map has keys of String and values of arbitrary type. To set a property in the context you use the `java.util.Map.put()` method.

Tip

While you can set properties in both the request and the response context, only the changes made to the request context have any impact on message processing. The properties in the response context are reset when each remote invocation is completed on the current thread.

The code shown in Example 181 on page 289 changes the address of the target service provider by setting the value of the `BindingProvider.ENDPOINT_ADDRESS_PROPERTY`.

Example 181. Setting a Request Context Property

```
// Set request context property.
java.util.Map<String, Object> requestContext =
     ((javax.xml.ws.BindingProvider)port).getRequestContext();
requestContext.put(BindingProvider.ENDPOINT_ADDRESS_PROPERTY, "http://localhost:8080/wid
gets");

// Invoke an operation.
port.SomeOperation();
```

Important

Once a property is set in the request context its value is used for all subsequent remote invocations. You can change the value and the changed value will then be used.

Supported contexts

Artix ESB supports the following context properties in consumer implementations:

Table 25. Consumer Context Properties

Base Class	
Property Name	**Description**
`javax.xml.ws.BindingProvider`	
`ENDPOINT_ADDRESS_PROPERTY`	Specifies the address of the target service. The value is stored as a `String`.
`USERNAME_PROPERTY`[a]	Specifies the username used for HTTP basic authentication. The value is stored as a `String`.
`PASSWORD_PROPERTY`[b]	Specifies the password used for HTTP basic authentication. The value is stored as a `String`.
`SESSION_MAINTAIN_PROPERTY`[c]	Specifies if the client wishes to maintain session information. The value is stored as a `Boolean`.
`org.apache.cxf.ws.addressing.JAXWSAConstants`	
`CLIENT_ADDRESSING_PROPERTIES`	Specifies the WS-Addressing information used by the consumer to contact the desired service provider. The value is stored as a `org.apache.cxf.ws.addressing.AddressingProperties`.
`org.apache.cxf.transports.jms.context.JMSConstants`	
`JMS_CLIENT_REQUEST_HEADERS`	Contains the JMS headers for the message. For more information see Working with JMS Message Properties on page 291.

[a]This property is overridden by the username defined in the HTTP security settings.

[b]This property is overridden by the password defined in the HTTP security settings.

[c]The Artix ESB ignores this property.

Working with JMS Message Properties

The Artix ESB JMS transport has a context mechanism that can be used to inspect a JMS message's properties. The context mechanism can also be used to set a JMS message's properties.

Inspecting JMS Message Headers

Consumers and services use different context mechanisms to access the JMS message header properties. However, both mechanisms return the header properties as a `org.apache.cxf.transports.jms.context.JMSMessageHeadersType` object.

Getting the JMS Message Headers in a Service

To get the JMS message header properties from the `WebServiceContext` do the following:

1. Obtain the context as described in Obtaining a context on page 280.
2. Get the message headers from the message context using the message context's `get()` method with the parameter

   `org.apache.cxf.transports.jms.JMSConstants.JMS_SERVER_HEADERS`.

Example 182 on page 292 shows code for getting the JMS message headers from a service's message context:

Example 182. Getting JMS Message Headers in a Service Implementation

```
import org.apache.cxf.transport.jms.JMSConstants;
import org.apache.cxf.transports.jms.context.JMSMessageHeadersType;

@WebService(serviceName = "HelloWorldService",
                           portName = "HelloWorldPort",
                           endpointInterface = "org.apache.cxf.hello_world_jms.HelloWorld
PortType",
                           targetNamespace = "http://cxf.apache.org/hello_world_jms")
  public class GreeterImplTwoWayJMS implements HelloWorldPortType
  {
    @Resource
    protected WebServiceContext wsContext;
    ...

    @WebMethod
    public String greetMe(String me)
    {
      MessageContext mc = wsContext.getMessageContext();
      JMSMessageHeadersType headers = (JMSMessageHeadersType) mc.get(JMSConstants.JMS_SERV
ER_HEADERS);
       ...
     }
```

```
      ...
}
```

Getting JMS Message Header Properties in a Consumer

Once a message has been successfully retrieved from the JMS transport you can inspect the JMS header properties using the consumer's response context. In addition, you can see how long the client will wait for a response before timing out.

You can To get the JMS message headers from a consumer's response context do the following:

1. Get the response context as described in Obtaining a context on page 287.
2. Get the JMS message header properties from the response context using the context's `get()` method with

   `org.apache.cxf.transports.jms.JMSConstants.JMS_CLIENT_RESPONSE_HEADERS`

   as the parameter.

Example 183 on page 293 shows code for getting the JMS message header properties from a consumer's response context.

Example 183. Getting the JMS Headers from a Consumer Response Header

```
import org.apache.cxf.transports.jms.context.*;
// Proxy greeter initialized previously
❶BindingProvider  bp = (BindingProvider)greeter;
❷Map<String, Object> responseContext = bp.getResponseContext();
❸JMSMessageHeadersType responseHdr = (JMSMessageHeadersType)
                           responseContext.get(JMSConstants.JMS_CLIENT_REQUEST_HEADERS);
...
}
```

The code in Example 183 on page 293 does the following:

❶ Casts the proxy to a `BindingProvider`.

❷ Gets the response context.

❸ Retrieves the JMS message headers from the response context.

Inspecting the Message Header Properties

Standard JMS Header Properties

Table 26 on page 294 lists the standard properties in the JMS header that you can inspect.

Table 26. JMS Header Properties

Property Name	Property Type	Getter Method
Correlation ID	string	`getJMSCorralationID()`
Delivery Mode	int	`getJMSDeliveryMode()`
Message Expiration	long	`getJMSExpiration()`
Message ID	string	`getJMSMessageID()`
Priority	int	`getJMSPriority()`
Redelivered	boolean	`getJMSRedlivered()`
Time Stamp	long	`getJMSTimeStamp()`
Type	string	`getJMSType()`
Time To Live	long	`getTimeToLive()`

Optional Header Properties

In addition, you can inspect any optional properties stored in the JMS header using `JMSMessageHeadersType.getProperty()`. The optional properties are returned as a `List` of `org.apache.cxf.transports.jms.context.JMSPropertyType`. Optional properties are stored as name/value pairs.

Example

Example 184 on page 294 shows code for inspecting some of the JMS properties using the response context.

Example 184. Reading the JMS Header Properties

```
// JMSMessageHeadersType messageHdr retrieved previously
❶System.out.println("Correlation ID: "+messageHdr.getJMSCorrelationID());
❷System.out.println("Message Priority: "+messageHdr.getJMSPriority());
❸System.out.println("Redelivered: "+messageHdr.getRedelivered());

JMSPropertyType prop = null;
```

```
❹List<JMSPropertyType> optProps = messageHdr.getProperty();
❺Iterator<JMSPropertyType> iter = optProps.iterator();
❻while (iter.hasNext())
{
  prop = iter.next();
   System.out.println("Property name: "+prop.getName());
   System.out.println("Property value: "+prop.getValue());
}
```

The code in Example 184 on page 294 does the following:

❶ Prints the value of the message's correlation ID.

❷ Prints the value of the message's priority property.

❸ Prints the value of the message's redelivered property.

❹ Gets the list of the message's optional header properties.

❺ Gets an `Iterator` to traverse the list of properties.

❻ Iterates through the list of optional properties and prints their name and value.

Setting JMS Properties

Using the request context in a consumer endpoint, you can set a number of the JMS message header properties and the consumer endpoint's timeout value. These properties are valid for a single invocation. You will need to reset them each time you invoke an operation on the service proxy.

Note

You cannot set header properties in a service.

JMS Header Properties

Table 27 on page 296 lists the properties in the JMS header that you can set using the consumer endpoint's request context.

Table 27. Settable JMS Header Properties

Property Name	Property Type	Setter Method
Correlation ID	string	`setJMSCorralationID()`
Delivery Mode	int	`setJMSDeliveryMode()`
Priority	int	`setJMSPriority()`
Time To Live	long	`setTimeToLive()`

To set these properties do the following:

1. Create an `org.apache.cxf.transports.jms.context.JMSMessageHeadersType` object.
2. Populate the values you wish to set using the appropriate setter methods from Table 27 on page 296.
3. Set the values into the request context by calling the request context's `put()` method using `org.apache.cxf.transports.jms.JMSConstants.JMS_CLIENT_REQUEST_HEADERS`

as the first argument and the new `JMSMessageHeadersType` object as the second argument.

Optional JMS Header Properties

You can also set optional properties into the JMS header. Optional JMS header properties are stored in the `JMSMessageHeadersType` object that is used to set the other JMS header properties. They are stored as a `List` of `org.apache.cxf.transports.jms.context.JMSPropertyType`. To add optional properties to the JMS header do the following:

1. Create a `JMSPropertyType` object.
2. Set the property's name field using `setName()`.
3. Set the property's value field using `setValue()`.
4. Add the property to the JMS message header to the JMS message header using `JMSMessageHeadersType.getProperty().add(JMSPropertyType)`.
5. Repeat the procedure until all of the properties have been added to the message header.

Client Receive Timeout

In addition to the JMS header properties, you can set the amount of time a consumer endpoint will wait for a response before timing out. You set the value by calling the request context's `put()` method with `org.apache.cxf.transports.jms.JMSConstants.JMS_CLIENT_RECEIVE_TIMEOUT` as the first argument and a long representing the amount of time in milliseconds that you want to consumer to wait as the second argument.

Example

Example 185 on page 297 shows code for setting some of the JMS properties using the request context.

Example 185. Setting JMS Properties using the Request Context

```
import org.apache.cxf.transports.jms.context.*;
 // Proxy greeter initialized previously
❶InvocationHandler handler = Proxy.getInvocationHandler(greeter);


BindingProvider bp= null;
```

```
❷if (handler instanceof BindingProvider)
{
❸   bp = (BindingProvider)handler;
❹   Map<String, Object> requestContext = bp.getRequestContext();

❺   JMSMessageHeadersType requestHdr = new JMSMessageHeadersType();
❻   requestHdr.setJMSCorrelationID("WithBob");
❼   requestHdr.setJMSExpiration(3600000L);


❽   JMSPropertyType prop = new JMSPropertyType;
❾   prop.setName("MyProperty");
  prop.setValue("Bluebird");
❿   requestHdr.getProperty().add(prop);

11   requestContext.put(JMSConstants.CLIENT_REQUEST_HEADERS, requestHdr);

12   requestContext.put(JMSConstants.CLIENT_RECEIVE_TIMEOUT, new Long(1000));
}
```

The code in Example 185 on page 297 does the following:

❶ Gets the `InvocationHandler` for the proxy whose JMS properties you want to change.
❷ Checks to see if the `InvocationHandler` is a `BindingProvider`.
❸ Casts the returned `InvocationHandler` object into a `BindingProvider` object to retrieve the request context.
❹ Gets the request context.
❺ Creates a `JMSMessageHeadersType` object to hold the new message header values.
❻ Sets the Correlation ID.
❼ Sets the Expiration property to 60 minutes.
❽ Creates a new `JMSPropertyType` object.
❾ Sets the values for the optional property.
❿ Adds the optional property to the message header.
11 Sets the JMS message header values into the request context.
12 Sets the client receive timeout property to 1 second.

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