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Chapter 1. Introduction to Service Creation with Talend ESB

This manual covers the Apache CXF 2.7.x series.

Talend ESB provides users with an easy-to-use solution for service enablement. Talend ESB incorporates the industry leading open source Apache CXF implementation of JAX-WS and helps you create new services and also service enable your existing applications and interfaces. It provides a lightweight, modular architecture that is based on the popular Spring Framework, so it works with your application, regardless of the platform on which it is running. It can be run as a stand-alone Java applications, as part of a servlet engine, such as Tomcat, as an OSGi bundle on an OSGi container such as Equinox, or within a JEE server.

Talend ESB supports the creation of SOAP and REST web services, with full WS-*functionality, including support for WS- Addressing, WS-Reliable Messaging, and WS-Security over both HTTP and JMS transports. Developers use a declarative, policy-centric approach to enable different qualities of service through configuration, rather than code.

CXF has been tested against the broadest set of vendor implementations for the various WS standards. Users benefit from this interoperability testing, which reduces the overall cost and complexity for application integration.

The Talend ESB distribution goes beyond Apache CXF, with support for OSGi containers along with illustrative examples, freely available for download. CXF development tools include support for Maven plug-ins, WSDL document creation, and Spring configuration generation.
Chapter 2. JAX-WS Development

CXF implements the JAX-WS APIs which make building web services easy. JAX-WS encompasses many different areas: Generating WSDL from Java classes and generating Java classes from WSDL, a Provider API which allows you to create simple messaging receiving server endpoints, and a Dispatch API which allows you to send raw XML messages to server endpoints. Apache CXF supports a variety of web service specifications including WS-Addressing, WS-Policy, WS-ReliableMessaging and WS-Security.
2.1. JAX-WS Overview

Architectural aspects of CXF include the following:

2.1.1. Spring Integration

Spring is a first class citizen with Apache CXF. CXF supports the Spring 2.0 XML syntax, making it trivial to declare endpoints which are backed by Spring and inject clients into your application.

2.1.2. Transports

CXF works with many different transports. Currently CXF includes support for HTTP, JMS, and Local (that is, 'in-JVM') transports. The local transport is unique in that it will not work across machines, but simply sends messages in memory. You can also configure the local transport to avoid serialization by using the Object binding or the colocation feature if desired. You can also write your own transport.

2.1.3. Support for Various Databindings between XML and Java

CXF provides support for multiple data bindings, including JAXB, XML Beans, and Aegis Databinding (2.0.x), is our own databinding library that makes development of code-first web services incredibly easy. Unlike JAXB, you don't need annotations at all. It also works correctly with a variety of datatypes such as Lists, Maps, Dates, etc. right out of the box. If you’re building a prototype web services that’s really invaluable as it means you have to do very little work to get up and running.

2.1.4. Bindings

Bindings map a particular service’s messages to a particular protocol. CXF includes support for several different bindings. The SOAP binding, which is the default, maps messages to SOAP and can be used with the various WS-* modules inside CXF. The Pure XML binding avoids serialization of a SOAP envelope and just sends a raw XML message. There is also an HTTP Binding which maps a service to HTTP using RESTful semantics.

2.1.5. Message Interception and Modification

Many times you may want to provide functionality for your application that works at a low level with XML messages. This commonly occurs through functionality referred to as Handlers or Interceptors. Handlers/Interceptors are useful for:
• Performing authentication based on Headers
• Processing custom headers
• Transforming a message (i.e. via XSLT or GZip)
• Redirecting a message
• Getting access to the raw I/O or XML stream

2.1.6. JAX-WS Handlers

If you are using the JAX-WS frontend, JAX-WS supports the concept of logical and protocol handlers. Protocol handlers allow you to manipulate the message in its raw, often XML-based, form - i.e. a SAAJ SOAPMessage. Logical handlers allow you to manipulate the message after its already been bound from the protocol to the JAXB object that your service will receive.

2.1.7. Interceptors

Interceptors provide access to all the features that CXF has to offer - allowing you to do just about anything, including manipulating the raw bytes or XML of the message.

2.1.8. Transmitting Binary Data

CXF provides facilities to transmit binary data efficiently via a standard called MTOM. Normally binary data inside an XML message must be Base64 encoded. This results in processing overhead and increases message size by 30%. If you use MTOM, CXF will send/receive MIME messages with the message stored as a MIME attachment, just like email. This results in much more efficient communication and allows you to transmit messages much larger than memory.

2.1.9. WS-* Support

CXF supports a variety of web service specifications including WS-Addressing, WS-Policy, WS-ReliableMessaging and WS-Security.

2.1.10. Invokers

Invokers allow you to customize how a particular method or backend service object is executed. This is particularly useful if your underlying service objects are not plain javabeans and instead need to be created or looked up via a custom factory.
2.2. JAX-WS Service Development Options

2.2.1. JAX-WS Annotated Services from Java

The JAX-WS APIs include a set of annotations which allow you to build services using annotated classes. These services are based on a single class which contains a set of operations.

Here’s a simple example:

```java
@WebService
public class Hello {
    public String sayHi(String name) {
        return "Hello " + name;
    }
}
```

JAX-WS includes many more annotations as well such as:

- `@WebMethod` - allows you to customize the operation name, exclude the operation from inclusion in the service, etc
- `@WebParam` - allows you to customize a parameter's name, namespace, direction (IN or OUT), etc
- `@WebResult` - allows you to customize the return value of the web service call

Data is marshalled from XML to Java and vice versa via the JAXB data-binding.

Services are publish via one of two means:

- The JAX-WS standard Endpoint APIs
- CXF’s XML configuration format - i.e. `<jaxws:endpoint ... />`

2.2.2. JAX-WS Annotated Services from WSDL

If you have existing WSDLs for your service or wish to write your WSDL first and then generate classes, CXF has many tools to help you do this.

The WSDL2Java tool will generate a JAX-WS annotated service and server stub from your WSDL. You can run it one of three ways:

- The command line
- The Maven plugin
- With the WSDL2Java API
Note that CXF generally restricts WSDL support to WSI-BP, not the full WSDL 1.1 specification.

2.2.3. Developing a Service using JAX-WS

You can develop a service using one of two approaches:

• Start with a WSDL contract and generate Java objects to implement the service.

• Start with a Java object and service enable it using annotations.

For new development the preferred path is to design your services in WSDL and then generate the code to implement them. This approach enforces the concept that a service is an abstract entity that is implementation neutral. It also means you can spend more time working out the exact interface your service requires before you start coding.

However, there are many cases where you may need to service enable an existing application. While JAX-WS eases the process, it does require that you make some changes to source code of your application. You will need to add annotations to the source. It also requires that you migrate your code to Java 5.0.

2.2.3.1. WSDL First Development

Using the WSDL first model of service development, you start with a WSDL document that defines the service you wish to implement. This WSDL document could be obtained from another developer, a system architect, a UDDI registry, or you could write it yourself. The document must contain at least a fully specified logical interface before you can begin generating code from it.

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

1. Generate starting point code.
2. Implement the service’s operations.
3. Publish 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. 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 endpoints implementing the service.

The `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. `wsdl2java` provides a number of arguments for controlling the generated code.
Running wsdl2java

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

```
wsdl2java -ant -impl -server -d outputDir myService.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 portType element in the WSDL document.
- The `-server` argument generates a simple `main()` to launch your service as a stand alone application.
- The `-d outputDir` argument tells `wsdl2java` to write the generated code to a directory called `outputDir`.
- `myService.wsdl` is the WSDL document from which code is generated.

Generated code

Table 1 describes the files generated for creating a service.

<table>
<thead>
<tr>
<th>File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>portTypeName.java</td>
<td>The SEI. This file contains the interface your service implements. You should not edit this file.</td>
</tr>
<tr>
<td>serviceName.java</td>
<td>The endpoint. This file contains the Java class your clients will use to make requests on the service.</td>
</tr>
<tr>
<td>portTypeNameImpl.java</td>
<td>The skeleton implementation class. You will modify this file to implement your service.</td>
</tr>
<tr>
<td>ImplPort_Server.java</td>
<td>A basic server <code>main()</code> that allows you to deploy your service as a stand alone process.</td>
</tr>
</tbody>
</table>

Implementing the Service

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 for your service with `wsdl2java` ’s `-impl` flag.

💡 If your service’s contract included 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 service implementation code consists of two files:

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

**Implement the operation’s logic**

You provide the business logic for your service’s operations by completing the stub methods in `portTypeNameImpl.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 CXF specific APIs that you can use to access some advanced features.

**Example**

For example, an implementation class for a service that defined the operations `sayHi` and `greetMe` may look like the below example.

**Example 2.1. Implementation of the Greeter Service**

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

**2.2.3.2. Java First Development**

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

1. Create a Service Endpoint Interface (SEI) that defines the methods you wish to expose as a service.
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 the required annotations to your code.

3. Generate the WSDL contract for your service.

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

4. Publish the service.

**Creating the SEI**

The service endpoint interface (SEI) is the piece of Java code that is shared between a service and the consumers that make requests on it. 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 services and consumers that use the SEI.

  The recommended way to do green field service development is to start by creating a WSDL contract that defines the service and its interfaces.

- **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.

    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.

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.
The below shows a simple SEI for a stock updating service.

**Example 2.2. Simple SEI**

```java
package org.apache.cxf;

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.

The below shows a class for implementing the above interface.

**Example 2.3. Implementation for SEI**

```java
package org.apache.cxf;

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));
        Date retDate = new Date();
        retVal.setTime(retDate.toString());
        return(retVal);
    }
}
```

**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.

  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>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>Specifies the name of the service interface. This property is mapped to the name attribute of the <code>wsdl:portType</code> element that defines the service's interface in a WSDL contract. The default is to append <code>PortType</code> to the name of the implementation class.</td>
</tr>
<tr>
<td>targetNamespace</td>
<td>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.</td>
</tr>
<tr>
<td>serviceName</td>
<td>Specifies the name of the published service. This property is mapped to the <code>name</code> attribute of the <code>wsdl:service</code> element that defines the published service. The default is to use the name of the service's implementation class. <strong>Note:</strong> Not allowed on the SEI</td>
</tr>
<tr>
<td>wsdlLocation</td>
<td>Specifies the URI at which the service's WSDL contract is stored. The default is the URI at which the service is deployed.</td>
</tr>
<tr>
<td>endpointInterface</td>
<td>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. <strong>Note:</strong> Not allowed on the SEI</td>
</tr>
<tr>
<td>portName</td>
<td>Specifies the name of the endpoint at which the service is published. This property is mapped to the <code>name</code> attribute of the <code>wsdl:port</code> element that specifies the endpoint details for a published service. The default is the append <code>Port</code> to the name of the service's implementation class. <strong>Note:</strong> Not allowed on the SEI</td>
</tr>
</tbody>
</table>

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.

The below shows the interface defined in above [10] with the `@WebService` annotation.
Example 2.4. Interface with the @WebService Annotation

```java
package com.mycompany.demo;

import javax.ws.*;

@WebService(name="quoteUpdater",
    targetNamespace="http://cxf.apache.org",
    wsdlLocation="http://somewhere.com/quoteExampleService?wsdl")
public interface QuoteReporter {
    public Quote getQuote(@WebParam(name="ticker") String ticker);
}
```

The @WebService annotation above does the following:

1. Specifies that the value of the name attribute of the wsd1:portType element defining the service interface is quoteUpdater.

2. Specifies that the target namespace of the service is http://cxf.apache.org.

3. Specifies that the service will use the pre-defined WSDL contract published at http://somewhere.com/quoteExampleService?wsdl.

The @WebParam annotation is necessary as java interfaces do not store the Parameter name in the .class file. So if you leave out the annotation your parameter will be named arg0.

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 the next example the property needs to be set to the full name of the SEI.

Example 2.5. Annotated Service Implementation Class

```java
package org.apache.cxf;

import javax.ws.*;

@WebService(endpointInterface="org.apache.cxf.quoteReporter",
    targetNamespace="http://cxf.apache.org",
    portName="StockQuotePort",
    serviceName="StockQuoteReporter")
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 an endpoint. The
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.

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 precedent.

The following table shows the properties for the @SOAPBinding annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>style</td>
<td>Style.DOCUMENT (default) Style.RPC</td>
<td>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 <code>soap:body</code> 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.</td>
</tr>
<tr>
<td>use</td>
<td>Use.LITERAL (default) Use.ENCODED</td>
<td>Specifies how the data of the SOAP message is streamed.</td>
</tr>
</tbody>
</table>
| parameterStyle    | 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
<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>output parameters are wrapped into a single element in the response message.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If you set the style to RPC you must use the \texttt{WRAPPED} parameter style.</td>
</tr>
</tbody>
</table>

The below shows an SEI that uses rpc/literal SOAP messages.

Example 2.6. Specifying an RPC/LITERAL SOAP Binding

```java
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 \texttt{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 \texttt{wsdl:operation} element describing the operation to which the method is associated.

The following table describes the properties of the @WebMethod annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>operationName</td>
<td>Specifies the value of the associated \texttt{wsdl:operation} element’s name. The default value is the name of the method.</td>
</tr>
<tr>
<td>action</td>
<td>Specifies the value of the \texttt{soapAction} attribute of the \texttt{soap:operation} element generated for the method. The default value is an empty string.</td>
</tr>
<tr>
<td>exclude</td>
<td>Specifies if the method should be excluded from the service interface. The default is \texttt{false}.</td>
</tr>
</tbody>
</table>
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.

The following table describes the properties of the @RequestWrapper annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>localName</td>
<td>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.</td>
</tr>
<tr>
<td>targetNamespace</td>
<td>Specifies the namespace under which the XML wrapper element is defined. The default value is the target namespace of the SEI.</td>
</tr>
<tr>
<td>className</td>
<td>Specifies the full name of the Java class that implements the wrapper element.</td>
</tr>
</tbody>
</table>

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.

The following table describes the properties of the @ResponseWrapper annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>localName</td>
<td>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.</td>
</tr>
<tr>
<td>targetNamespace</td>
<td>Specifies the namespace under which the XML wrapper element is defined. The default value is the target namespace of the SEI.</td>
</tr>
<tr>
<td>className</td>
<td>Specifies the full name of the Java class that implements the wrapper element.</td>
</tr>
</tbody>
</table>

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.

The following table describes the properties of the @WebFault annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>Specifies the local name of the fault element.</td>
</tr>
<tr>
<td>targetNamespace</td>
<td>Specifies the namespace under which the fault element is defined. The default value is the target namespace of the SEI.</td>
</tr>
<tr>
<td>faultName</td>
<td>Specifies the full name of the Java class that implements the exception.</td>
</tr>
</tbody>
</table>

⚠️ **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**

The next example shows an SEI whose methods are annotated.

**Example 2.7. SEI with Annotated Methods**

```java
package org.apache.cxf;

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

@WebService(name="quoteReporter")
public interface QuoteReporter {
    @WebMethod(operationName="getStockQuote")
    @RequestWrapper(targetNamespace="http://demo.mycompany.com/types", className="java.lang.String")
    @ResponseWrapper(targetNamespace="http://demo.mycompany.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.

The following table describes the properties of the @WebParam annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>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 argN, where N is replaced with the zero-based argument index (i.e., arg0, arg1, etc.).</td>
</tr>
<tr>
<td>targetNamespace</td>
<td>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.</td>
</tr>
<tr>
<td>mode</td>
<td>Specifies the direction of the parameter: Mode.IN (default), Mode.OUT, Mode.INOUT</td>
</tr>
<tr>
<td>header</td>
<td>Specifies if the parameter is passed as part of the SOAP header. Values of true or false (default).</td>
</tr>
<tr>
<td>partName</td>
<td>Specifies the value of the name attribute of the wsdl:part element for the parameter when the binding is document.</td>
</tr>
</tbody>
</table>

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.

The following table describes the properties of the @WebResult annotation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>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.</td>
</tr>
<tr>
<td>targetNamespace</td>
<td>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.</td>
</tr>
<tr>
<td>header</td>
<td>Specifies if the return value is passed as part of the SOAP header.</td>
</tr>
<tr>
<td>partName</td>
<td>Specifies the value of the name attribute of the wsdl:part element for the return value when the binding is document.</td>
</tr>
</tbody>
</table>

Example

This example shows an SEI that is fully annotated.
Example 2.8. Fully Annotated SEI

```java
package org.apache.cxf;

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

@WebService(name="quoteReporter")
@SOAPBinding(style=Style.RPC, use=Use.LITERAL)
public interface QuoteReporter {
    @WebMethod(operationName="getStockQuote")
    @RequestWrapper(targetNamespace="http://demo.mycompany.com/types",
    className="java.lang.String")
    @ResponseWrapper(targetNamespace="http://demo.mycompany.com/types",
    className="org.eric.demo.Quote")
    @WebResult(targetNamespace="http://demo.mycompany.com/types",
    name="updatedQuote")
    public Quote getQuote(
        @WebParam(targetNamespace="http://demo.mycompany.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 `java2wsdl` command.

Generated WSDL from an SEI

The below example shows the WSDL contract generated for the SEI shown above.

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions targetNamespace="http://demo.eric.org/
    xmlns:tns="http://demo.eric.org/
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:ns1=""
    xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
    xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
    <xsd:types>
        <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:types>
```
2.2.4. JAX-WS Configuration

The following sections list JAX-WS specific configuration items.

2.2.4.1. Configuring an Endpoint

A JAX-WS Endpoint can be configured in XML in addition to using the JAX-WS APIs. Once you’ve created your server implementation, you simply need to provide the class name and an address. Here is a simple example:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"

```
Be sure to include the JAX-WS schemaLocation attribute specified on the root beans element. This allows CXF to validate the file and is required. Also note the namespace declarations at the end of the <jaxws:endpoint/> tag--these are required because the combined "{namespace}localName" syntax is presently not supported for this tag’s attribute values.

The jaxws:endpoint element (which appears to create an EndpointImpl under the covers) supports many additional attributes:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>endpointName</td>
<td>The endpoint name this service is implementing, it maps to the wsd1:port@name. In the format of “ns:ENDPOINT_NAME” where ns is a namespace prefix valid at this scope.</td>
</tr>
<tr>
<td>publish</td>
<td>Whether the endpoint should be published now, or whether it will be published at a later point.</td>
</tr>
<tr>
<td>serviceName</td>
<td>The service name this service is implementing, it maps to the wsd1:service@name. In the format of “ns:SERVICE_NAME” where ns is a namespace prefix valid at this scope.</td>
</tr>
<tr>
<td>wsdlLocation</td>
<td>The location of the WSDL. Can be on the classpath, file system, or be hosted remotely.</td>
</tr>
<tr>
<td>bindingUri</td>
<td>The URI, or ID, of the message binding for the endpoint to use. For SOAP the binding URI(ID) is specified by the JAX-WS specification. For other message bindings the URI is the namespace of the WSDL extensions used to specify the binding.</td>
</tr>
<tr>
<td>address</td>
<td>The service publish address</td>
</tr>
<tr>
<td>bus</td>
<td>The bus name that will be used in the jaxws endpoint.</td>
</tr>
<tr>
<td>implementor</td>
<td>The implementor of jaxws endpoint. You can specify the implementor class name here, or just the ref bean name in the format of “#REF_BEAN_NAME”</td>
</tr>
<tr>
<td>implementorClass</td>
<td>The implementor class name, it is really useful when you specify the implementor with the ref bean which is wrapped by using Spring AOP</td>
</tr>
<tr>
<td>createdFromAPI</td>
<td>This indicates that the endpoint bean was already created using jaxws API's thus at runtime when parsing the bean spring can use these values rather than the default ones. It's important that when this is true, the &quot;name&quot; of the bean is set to the port name of the endpoint being created in the form &quot;[<a href="http://service.target.namespace">http://service.target.namespace</a>] PortName&quot;.</td>
</tr>
<tr>
<td>publishedEndpointUrl</td>
<td>The URL that is placed in the address element of the wsdl when the wsdl is retrieved. If not specified, the address listed above is used. This parameter allows setting the ‘public’ URL that may not be the same as the URL the service is deployed on. (for example, the service is behind a proxy of some sort).</td>
</tr>
</tbody>
</table>
It also supports many child elements:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>jaxws:executor</td>
<td>A Java executor which will be used for the service. This can be supplied using the Spring <code>&lt;bean class=&quot;MyExecutor&quot;/&gt;</code> syntax.</td>
</tr>
<tr>
<td>jaxws:inInterceptors</td>
<td>The incoming interceptors for this endpoint. A list of <code>&lt;bean&gt;</code>s or <code>&lt;ref&gt;</code>s. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code></td>
</tr>
<tr>
<td>jaxws:inFaultInterceptors</td>
<td>The incoming fault interceptors for this endpoint. A list of <code>&lt;bean&gt;</code>s or <code>&lt;ref&gt;</code>s. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code></td>
</tr>
<tr>
<td>jaxws:outInterceptors</td>
<td>The outgoing interceptors for this endpoint. A list of <code>&lt;bean&gt;</code>s or <code>&lt;ref&gt;</code>s. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code></td>
</tr>
<tr>
<td>jaxws:outFaultInterceptors</td>
<td>The outgoing fault interceptors for this endpoint. A list of <code>&lt;bean&gt;</code>s or <code>&lt;ref&gt;</code>s. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code></td>
</tr>
<tr>
<td>jaxws:handlers</td>
<td>The JAX-WS handlers for this endpoint. A list of <code>&lt;bean&gt;</code>s or <code>&lt;ref&gt;</code>s. Each should implement <code>javax.xml.ws.handler.Handler</code> or <code>javax.xml.ws.handler.soap.SOAPHandler</code> (Note that @HandlerChain annotations on the service bean appear to be ignored)</td>
</tr>
<tr>
<td>jaxws:properties</td>
<td>A properties map which should be supplied to the JAX-WS endpoint. See below.</td>
</tr>
<tr>
<td>jaxws:dataBinding</td>
<td>Which DataBinding to use in the endpoint. This can be supplied using the Spring <code>&lt;bean class=&quot;MyDataBinding&quot;/&gt;</code> syntax.</td>
</tr>
<tr>
<td>jaxws:binding</td>
<td>You can specify the BindingFactory for this endpoint to use. This can be supplied using the Spring <code>&lt;bean class=&quot;MyBindingFactory&quot;/&gt;</code> syntax.</td>
</tr>
<tr>
<td>jaxws:features</td>
<td>The features that hold the interceptors for this endpoint. A list of <code>&lt;bean&gt;</code>s or <code>&lt;ref&gt;</code>s</td>
</tr>
<tr>
<td>jaxws:invoker</td>
<td>The invoker which will be supplied to this endpoint. This can be supplied using the Spring <code>&lt;bean class=&quot;MyInvoker&quot;/&gt;</code> syntax.</td>
</tr>
<tr>
<td>jaxws:schemaLocations</td>
<td>The schema locations for endpoint to use. A list of <code>&lt;schemaLocation&gt;</code>s</td>
</tr>
<tr>
<td>jaxws:serviceFactory</td>
<td>The service factory for this endpoint to use. This can be supplied using the Spring <code>&lt;bean class=&quot;MyServiceFactory&quot;/&gt;</code> syntax</td>
</tr>
</tbody>
</table>
If you are a Spring user, you’ll notice that the `jaxws:properties` element follows the Spring Map syntax.

### 2.2.4.2. Configuring a Spring Client (Option 1)

This technique lets you add a Web Services client to your Spring application. You can inject it into other Spring beans, or manually retrieve it from the Spring context for use by non-Spring-aware client code.

The easiest way to add a Web Services client to a Spring context is to use the `jaxws:client` element (similar to the `jaxws:endpoint` element used for the server side). Here’s a simple example:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"     
xmns:jaxws="http://cxf.apache.org/jaxws"     
xmns:xsi="http://www.w3.org/2001/XMLSchema-instance"     
xsi:schemaLocation="     
http://www.springframework.org/schema/beans     
http://www.springframework.org/schema/beans/spring-beans.xsd     
http://cxf.apache.org/jaxws     
http://cxf.apache.org/schemas/jaxws.xsd">
    <jaxws:client id="helloClient"     
    serviceClass="demo.spring.HelloWorld"     
    address="http://localhost:9002/HelloWorld"/>
</beans>
```

The attributes available on `jaxws:client` include:
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>String</td>
<td>A unique identified for the client, which is how other beans in the context will reference it</td>
</tr>
<tr>
<td>address</td>
<td>URL</td>
<td>The URL to connect to in order to invoke the service</td>
</tr>
<tr>
<td>serviceClass</td>
<td>Class</td>
<td>The fully-qualified name of the interface that the bean should implement (typically, same as the service interface used on the server side)</td>
</tr>
<tr>
<td>serviceName</td>
<td>QName</td>
<td>The name of the service to invoke, if this address/WSDL hosts several. It maps to the wsdl:service@name. In the format of “ns:SERVICE_NAME” where ns is a namespace prefix valid at this scope.</td>
</tr>
<tr>
<td>endpointName</td>
<td>QName</td>
<td>The name of the endpoint to invoke, if this address/WSDL hosts several. It maps to the wsdl:port@name. In the format of “ns:ENDPOINT_NAME” where ns is a namespace prefix valid at this scope.</td>
</tr>
<tr>
<td>bindingId</td>
<td>URI</td>
<td>The URI, or ID, of the message binding for the endpoint to use. For SOAP the binding URI(ID) is specified by the JAX-WS specification. For other message bindings the URI is the namespace of the WSDL extensions used to specify the binding.</td>
</tr>
<tr>
<td>bus</td>
<td>Bean Reference</td>
<td>The bus name that will be used in the jaxws endpoint (defaults to cxf).</td>
</tr>
<tr>
<td>username</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>password</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td>wsdlLocation</td>
<td>URL</td>
<td>A URL to connect to in order to retrieve the WSDL for the service. This is not required.</td>
</tr>
<tr>
<td>createdFromAPI</td>
<td>boolean</td>
<td>This indicates that the client bean was already created using jaxws API’s thus at runtime when parsing the bean spring can use these values rather than the default ones. It’s important that when this is true, the “name” of the bean is set to the port name of the endpoint being created in the form “[<a href="http://service.target.namespace">http://service.target.namespace</a>] PortName”.</td>
</tr>
</tbody>
</table>

It also supports many child elements:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>jaxws:inInterceptors</td>
<td>The incoming interceptors for this endpoint. A list of &lt;bean&gt; or &lt;ref&gt; elements. Each should implement org.apache.cxf.interceptor.Interceptor or org.apache.cxf.phase.PhaseInterceptor</td>
</tr>
<tr>
<td>jaxws:inFaultInterceptors</td>
<td>The incoming fault interceptors for this endpoint. A list of &lt;bean&gt; or &lt;ref&gt; elements. Each should implement org.apache.cxf.interceptor.Interceptor or org.apache.cxf.phase.PhaseInterceptor</td>
</tr>
<tr>
<td>jaxws:outInterceptors</td>
<td>The outgoing interceptors for this endpoint. A list of &lt;bean&gt; or &lt;ref&gt; elements. Each should implement org.apache.cxf.interceptor.Interceptor or org.apache.cxf.phase.PhaseInterceptor</td>
</tr>
<tr>
<td>jaxws:outFaultInterceptors</td>
<td>The outgoing fault interceptors for this endpoint. A list of &lt;bean&gt; or &lt;ref&gt; elements. Each should implement org.apache.cxf.interceptor.Interceptor or org.apache.cxf.phase.PhaseInterceptor</td>
</tr>
<tr>
<td>jaxws:features</td>
<td>The features that hold the interceptors for this endpoint. A list of &lt;bean&gt; of &lt;ref&gt; elements</td>
</tr>
<tr>
<td>jaxws:handlers</td>
<td>The JAX-WS handlers for this endpoint. A list of &lt;bean&gt; or &lt;ref&gt; elements. Each should implement javax.xml.ws.handler.Handler or javax.xml.ws.handler.soap.SOAPHandler . These are more portable than</td>
</tr>
</tbody>
</table>
Name | Description
--- | ---
xajws:properties | A properties map which should be supplied to the JAX-WS endpoint. See below.
xajws:binding | You can specify the BindingFactory for this endpoint to use. This can be supplied using the Spring `<bean class="MyBindingFactory"/>` syntax.
xajws:conduitSelector

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
</table>
| | CXF interceptors, but may cause the full message to be loaded in as a DOM (slower for large messages).
| jaxws:properties | A properties map which should be supplied to the JAX-WS endpoint. See below.
| jaxws:binding | Which DataBinding to use in the endpoint. This can be supplied using the Spring `<bean class="MyDataBinding"/>` syntax.
| jaxws:conduitSelector

Here is a more advanced example which shows how to provide interceptors, JAX-WS handlers, and properties:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:jaxws="http://cxf.apache.org/jaxws"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
                         http://www.springframework.org/schema/beans/spring-beans.xsd
                         http://cxf.apache.org/jaxws
                         http://cxf.apache.org/schemas/jaxws.xsd">
    <!-- Interceptors extend e.g. org.apache.cxf.phase.AbstractPhaseInterceptor -->
    <bean id="anotherInterceptor" class="..."/>
    <!-- Handlers implement e.g. javax.xml.ws.handler.soap.SOAPHandler -->
    <bean id="jaxwsHandler" class="..."/>
    <!-- The SOAP client bean -->
    <jaxws:client id="helloClient" serviceClass="demo.spring.HelloWorld" address="http://localhost:9002/HelloWorld">
        <jaxws:inInterceptors>
            <bean class="org.apache.cxf.interceptor.LoggingInInterceptor"/>
            <ref bean="anotherInterceptor"/>
        </jaxws:inInterceptors>
        <jaxws:handlers>
            <ref bean="jaxwsHandler"/>
        </jaxws:handlers>
        <jaxws:properties>
            <entry key="mtom-enabled" value="true"/>
        </jaxws:properties>
    </jaxws:client>
</beans>
```

### 2.2.4.3. Configuring a Spring Client (Option 2)

⚠ Building a Client using this configuration is only applicable for those wishing to inject a Client into their Spring ApplicationContext.

This approach requires more explicit Spring bean configuration than the previous option, and may require more configuration data depending on which features are used. To configure a client
this way, you’ll need to declare a proxy factory bean and also a client bean which is created by that proxy factory. Here is an example:

```xml
<beans xmlns="http://www.springframework.org/schema/beans" 
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" 
xmlns:jaxws="http://cxf.apache.org/jaxws" 
xsi:schemaLocation=" 
http://www.springframework.org/schema/beans 
http://www.springframework.org/schema/beans/spring-beans-2.0.xsd 
http://cxf.apache.org/jaxws 
http://cxf.apache.org/schemas/jaxws.xsd"> 
  <bean id="proxyFactory" 
    class="org.apache.cxf.jaxws.JaxWsProxyFactoryBean"> 
    <property name="serviceClass" value="demo.spring.HelloWorld"/> 
    <property name="address" value="http://localhost:9002/HelloWorld"/> 
  </bean> 
  <bean id="client" class="demo.spring.HelloWorld" 
    factory-bean="proxyFactory" factory-method="create"/> 
</beans>

The JaxWsProxyFactoryBean in this case takes two properties. The service class, which is the interface of the Client proxy you wish to create. The address is the address of the service you wish to call.

The second bean definition is for the client. In this case it implements the HelloWorld interface and is created by the proxyFactory <bean> by calling the create() method. You can then reference this "client" bean and inject it anywhere into your application. Here is an example of a very simple Java class which accesses the client bean:

```java
include org.springframework.context.support.ClassPathXmlApplicationContext;

public final class HelloWorldClient {

  private HelloWorldClient() {} 

  public static void main(String args[]) throws Exception {
    ClassPathXmlApplicationContext context = 
    new ClassPathXmlApplicationContext( 
      new String[]{"my/path/to/client-beans.xml"}); 
    HelloWorld client = (HelloWorld)context.getBean("client");
    String response = client.sayHi("Dan");
    System.out.println("Response: " + response);
    System.exit(0);
  }
}
```

The JaxWsProxyFactoryBean supports many other properties:

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>clientFactoryBean</td>
<td>The ClientFactoryBean used in construction of this proxy.</td>
</tr>
<tr>
<td>password</td>
<td>The password which the transport should use.</td>
</tr>
<tr>
<td>username</td>
<td>The username which the transport should use.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>wsdlURL</td>
<td>The wsdl URL the client should use to configure itself.</td>
</tr>
<tr>
<td>wsdlLocation</td>
<td>Appears to be the same as wsdlURL?</td>
</tr>
<tr>
<td>serviceName</td>
<td>The name of the service to invoke, if this address/WSDL hosts several. It maps to the wsdl:service@name. In the format of <code>ns:SERVICE_NAME</code> where ns is a namespace prefix valid at this scope.</td>
</tr>
<tr>
<td>endpointName</td>
<td>The name of the endpoint to invoke, if this address/WSDL hosts several. It maps to the wsdl:port@name. In the format of <code>ns:ENDPOINT_NAME</code> where ns is a namespace prefix valid at this scope.</td>
</tr>
<tr>
<td>inInterceptors</td>
<td>The incoming interceptors for this endpoint. A list of <code>&lt;bean&gt;</code> or <code>&lt;ref&gt;</code> elements. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code>.</td>
</tr>
<tr>
<td>inFaultInterceptors</td>
<td>The incoming fault interceptors for this endpoint. A list of <code>&lt;bean&gt;</code> or <code>&lt;ref&gt;</code> elements. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code>.</td>
</tr>
<tr>
<td>outInterceptors</td>
<td>The outgoing interceptors for this endpoint. A list of <code>&lt;bean&gt;</code> or <code>&lt;ref&gt;</code> elements. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code>.</td>
</tr>
<tr>
<td>outFaultInterceptors</td>
<td>The outgoing fault interceptors for this endpoint. A list of <code>&lt;bean&gt;</code> or <code>&lt;ref&gt;</code> elements. Each should implement <code>org.apache.cxf.interceptor.Interceptor</code> or <code>org.apache.cxf.phase.PhaseInterceptor</code>.</td>
</tr>
<tr>
<td>features</td>
<td>The features that hold the interceptors for this endpoint. A list of <code>&lt;bean&gt;</code> or <code>&lt;ref&gt;</code> elements.</td>
</tr>
<tr>
<td>handlers</td>
<td>A list of <code>&lt;bean&gt;</code> or <code>&lt;ref&gt;</code> elements pointing to JAX-WS handler classes to be used for this client. Each should implement <code>javax.xml.ws.handler.Handler</code> or <code>javax.xml.ws.handler.soap.SOAPHandler</code>. These are more portable than CXF interceptors, but may cause the full message to be loaded in as a DOM (slower for large messages).</td>
</tr>
<tr>
<td>bindingConfig</td>
<td>The URI, or ID, of the message binding for the endpoint to use. For SOAP the binding URI(ID) is specified by the JAX-WS specification. For other message bindings the URI is the namespace of the WSDL extensions used to specify the binding.</td>
</tr>
<tr>
<td>bindingId</td>
<td>A reference to a CXF bus bean. Must be provided if, for example, handlers are used. May require additional Spring context imports (e.g. to bring in the default CXF bus bean).</td>
</tr>
<tr>
<td>conduitSelector</td>
<td>Which DataBinding to use in the endpoint. This can be supplied using the Spring <code>&lt;bean class=&quot;MyDataBinding&quot;/&gt;</code> syntax.</td>
</tr>
<tr>
<td>dataBinding</td>
<td>A properties map which should be supplied to the JAX-WS endpoint.</td>
</tr>
</tbody>
</table>

Using some of the properties will require additional configuration in the Spring context. For instance, using JAX-WS handlers requires that you explicitly import several CXF Spring configurations, and assign the "bus" property of the JaxWsProxyFactoryBean like this:

```xml
<import resource="classpath:META-INF/cxf/cxf.xml"/>

<bean id="clientFactory" class="org.apache.cxf.jaxws.JaxWsProxyFactoryBean">
   <property name="serviceClass" value="demo.spring.HelloWorld"/>
   <property name="address" value="http://localhost:9002/HelloWorld"/>
   <property name="bus" ref="cxf"/>
</bean>
```
2.2.4.4. Configuring an Endpoint/Client Proxy Using CXF APIs

JAX-WS endpoints and client proxies are implemented on top of CXF’s frontend-neutral endpoint API. You can therefore use CXF APIs to enhance the functionality of a JAX-WS endpoint or client proxy, for example by adding interceptors.

To cast a client proxy to a CXF client:

```java
GreeterService gs = new GreeterService();
Greeter greeter = gs.getGreeterPort();
org.apache.cxf.endpoint.Client client =
    org.apache.cxf.frontend.ClientProxy.getClient(greeter);
org.apache.cxf.endpoint.Endpoint cxfEndpoint = client.getEndpoint();
cxfEndpoint.getOutInterceptors().add(...);
```

To cast a JAX-WS endpoint to a CXF server:

```java
javax.xml.ws.Endpoint jaxwsEndpoint =
    javax.xml.ws.Endpoint.publish(
        "http://localhost:9020/SoapContext/GreeterPort", new GreeterImpl());
org.apache.cxf.jaxws.EndpointImpl jaxwsEndpointImpl =
    (org.apache.cxf.jaxws.EndpointImpl)jaxwsEndpoint;
org.apache.cxf.endpoint.Server server = jaxwsEndpointImpl.getServer();
cxfEndpoint = server.getEndpoint();
cxfEndpoint.getOutInterceptors().add(...);
org.apache.cxf.service.Service cxfService = cxfEndpoint.getService();
cxfService.getOutInterceptors().add(...);
```

2.2.4.5. Configure the JAXWS Server/Client Using Spring

CXF provides `<jaxws:server>`, `<jaxws:client>` to configure the server/client side endpoint. Here are some examples:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:jaxws="http://cxf.apache.org/jaxws"
    xmlns:soap="http://cxf.apache.org/bindings/soap"
    xsi:schemaLocation="
        http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
        http://cxf.apache.org/bindings/soap
        http://cxf.apache.org/schemas/configuration/soap.xsd
        http://cxf.apache.org/jaxws
        http://cxf.apache.org/schemas/jaxws.xsd">

    <jaxws:server id="inlineImplementor"
        address="http://localhost:8080/simpleWithAddress">\
        <jaxws:serviceBean>\
            <bean class="org.apache.hello_world_soap_http.GreeterImpl"/>\
        </jaxws:serviceBean>
    </jaxws:server>

    <jaxws:server id="bookServer"
        serviceClass="org.myorg.mytype.AnonymousComplexTypeImpl"
        address="http://localhost:8080/act"
        bus="cxf">
```
Since JAX-WS frontend server and client spring configuration parser are inherited from the simple frontend, please see Simple Frontend Configuration for the attribute and element definitions.

### 2.2.4.6. Configure the JAXWS Server Using SpringBoot

Here is an example:

```java
import org.apache.cxf.Bus;
import org.apache.cxf.jaxws.EndpointImpl;
import org.apache.cxf.transport.servlet.CXFServlet;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.EnableAutoConfiguration;
import org.springframework.boot.builder.SpringApplicationBuilder;
import org.springframework.boot.context.embedded.EmbeddedServletContainerFactory;
import org.springframework.boot.context.embedded.ServletRegistrationBean;
import org.springframework.boot.context.web.SpringBootServletInitializer;
import org.springframework.context.ApplicationContext;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
import org.springframework.context.annotation.ImportResource;

@Configuration
@EnableAutoConfiguration
@ImportResource({ "classpath:META-INF/cxf/cxf.xml" })
public class Application extends SpringBootServletInitializer {
```
```java
@Autowired
private ApplicationContext applicationContext;

public static void main(String[] args) {
    SpringApplication.run(Application.class, args);
}

// Replaces the need for web.xml
@Bean
public ServletRegistrationBean servletRegistrationBean(ApplicationContext context) {
    return new ServletRegistrationBean(new CXFServlet(), "/api/*");
}

// Replaces cxf-servlet.xml
@Bean
// <jaxws:endpoint id="helloWorld"
// implementor="demo.spring.service.HelloWorldImpl"
// address="/HelloWorld"/>
public EndpointImpl helloService() {
    Bus bus = (Bus) applicationContext.getBean(Bus.DEFAULT_BUS_ID);
    Object implementor = new HelloWorldImpl();
    EndpointImpl endpoint = new EndpointImpl(bus, implementor);
    endpoint.publish("/hello");
    return endpoint;
}

// Used when deploying to a standalone servlet container, i.e. tomcat
@Override
protected SpringApplicationBuilder configure(SpringApplicationBuilder application) {
    return application.sources(Application.class);
}
```

### 2.2.5. JAX-WS Providers

JAX-WS Providers allow you to create services which work at the message level - as opposed to the operation level as with annotated classes. The have a single operation "invoke" which receives either the message payload (i.e. the SOAP Body) or the whole message itself (i.e. the SOAP Envelope).

Here's a simple example:

```java
@WebService
public class HelloProvider {
    public Source invoke(Source request) {
        return ....;
    }
}
```

Services are publish via one of two means:

- The JAX-WS standard Endpoint APIs
• CXF’s XML configuration format - i.e. `<jaxws:endpoint ... />

2.2.5.1. 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.

```java
@WebServiceProvider
@ServiceMode(value=Service.Mode.MESSAGE)
public class stockQuoteProvider implements Provider<SOAPMessage> { 
    ...
}
```

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.

💡 When working with a binding that does not use special wrappers, such as the 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.

```java
@WebServiceProvider
@ServiceMode(value=Service.Mode.PAYLOAD)
```
public class stockQuoteProvider implements Provider<DOMSource> {
...}

If you do not provide the @ServiceMode annotation, the Provider implementation will default to using payload mode.

2.2.5.2. 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.

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. 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 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 \texttt{wsdl:operation}
element that corresponds to the operation being invoked.

  \textit{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 \texttt{wsdl:part} element referred to by the \texttt{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.

  \textit{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.

\textbf{Implementing the invoke()} method

The Provider interface has only one method, \texttt{invoke()}, that needs to be implemented. \texttt{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.

\textbf{Examples}

The following shows a Provider implementation that works with SOAPMessage objects in
message mode.

```java
import javax.xml.ws.Provider;
import javax.xml.ws.Service;
import javax.xml.ws.ServiceMode;
import javax.xml.ws.WebServiceProvider;
```
The code does the following:

1. 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.

2. Specifies that this Provider implementation uses message mode.

3. Provides the required default public constructor.

4. Provides an implementation of the invoke() method that takes a SOAPMessage object and returns a SOAPMessage object.

5. Extracts the request message from the body of the incoming SOAP message.

6. Checks the root element of the request message to determine how to process the request.

7. Creates the factories needed for building the response.

8. Builds the SOAP message for the response.

9. Returns the response as a SOAPMessage object.

The following shows an example of a Provider implementation using DOMSource objects in payload mode.
The code does the following:

1. 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`.

2. Specifies that this Provider implementation uses payload mode.

3. Provides the required default public constructor.

4. Provides an implementation of the `invoke()` method that takes a `DOMSource` object and returns a `DOMSource` object.

### 2.2.6. WebserviceContext

The `WebserviceContext` interface is part of the JAX-WS specification. It allows you to access several context informations the runtime has associated to your service call.

The following code fragment show how to use some parts of the `WebserviceContext`.
2.3. JAX-WS Client Development Options

2.3.1. WSDL2Java generated Client

One of the most common scenarios is that where you have a service which you may or not manage and this service has a WSDL. In this case you'll often want to generate a client from the WSDL. This provides you with a strongly typed interface by which to interact with the service. Once you've generated a client, typical usage of it will look like so:

```java
HelloService service = new HelloService();
Hello client = service.getHelloHttpPort();
String result = client.sayHi("Joe");
```

The WSDL2Java tool will generate JAX-WS clients from your WSDL. You can run WSDL2Java one of three ways:

- The command line
- The Maven Plugin
- With the WSDL2Java API

For more in depth information read Developing a JAX-WS consumer or see the Hello World demos inside the distribution.

2.3.2. JAX-WS Proxy

Instead of using a wsdl2java-generated stub client directly, you can use Service.create to create Service instances, the following code illustrates this process:

```java
import java.net.URL;
import javax.xml.ws.Service;
...

URL wsdlURL = new URL("http://localhost/hello?wsdl");
QName SERVICE_NAME = new QName("http://apache.org/hello_world_soap_http",
    "SOAPService");
Service service = Service.create(wsdlURL, SERVICE_NAME);
Greeter client = service.getPort(Greeter.class);
String result = client.greetMe("test");
```
2.3.3. JAX-WS Dispatch APIs

JAX-WS provides the "dispatch" mechanism which makes it easy to dynamically invoke services which you have not generated a client for. Using the Dispatch mechanism you can create messages (which can be JAXB objects, Source objects, or a SAAJMessage) and dispatch them to the server. A simple example might look like this:

```java
import java.net.URL;
import javax.xml.transform.Source;
import javax.xml.ws.Dispatch;
import javax.xml.ws.Service;
...

URL wsdlURL = new URL("http://localhost/hello?wsdl");
Service service = Service.create(wsdlURL, new QName("HelloService");
Dispatch<Source> disp = service.createDispatch(new QName("HelloPort"),
    Source.class, Service.Mode.PAYLOAD);

Source request = new StreamSource("<hello/>")
Source response = disp.invoke(request);
```

NOTE: you can also use dispatches without a WSDL.

For more in depth information see the Hello World demos inside the distribution.

2.3.4. Usage Modes

2.3.4.1. 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.

2.3.4.2. 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.

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.

### 2.3.4.3. 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 stripped away and only the body of the message is left.

💡 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.

### 2.3.5. Data Types

#### 2.3.5.1. 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

#### 2.3.5.2. Using Source objects

A Dispatch object 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
- SAXSource
- StreamSource
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.

2.3.5.3. 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.

2.3.5.4. 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.

2.3.5.5. 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.

2.3.6. Working with Dispatch Objects

2.3.6.1. 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.

### 2.3.6.2. 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.

2. Create the Dispatch object using the Service object's createDispatch() method.

```java
public Dispatch<T> createDispatch(QName portName, java.lang.Class<T> type, Service.Mode mode) throws WebServiceException;
```

If you are using JAXB objects the method signature for `createDispatch()` is:

```java
public Dispatch<T> createDispatch(QName portName, javax.xml.bind.JAXBContext context, Service.Mode mode) throws WebServiceException;
```

The following table describes the parameters for `createDispatch()`:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>portName</td>
<td>Specifies the QName of the wsdl:port element that represent the service provider on which the Dispatch object will make invocations.</td>
</tr>
<tr>
<td>type</td>
<td>Specifies the data type of the objects used by the Dispatch object.</td>
</tr>
<tr>
<td>mode</td>
<td>Specifies the usage mode for the Dispatch object.</td>
</tr>
</tbody>
</table>

The code below creates a Dispatch object that works with DOMSource objects in payload mode.

```java
package com.mycompany.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);
    }
}
```
2.3.6.3. 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 \texttt{wsdl:operation} element that corresponds to the operation being invoked.

  \textit{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 \texttt{wsdl:part} element referred to by the \texttt{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.

  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.

2.3.6.4. Synchronous invocation

For consumers that make synchronous invocations that generate a response, you use the Dispatch object’s \texttt{invoke}() method shown below.

\begin{Verbatim}
T invoke(T msg) throws WebServiceException;
\end{Verbatim}

The type of both the response and the request passed to the \texttt{invoke()} method are determined when the Dispatch object is created. For example if you created a Dispatch object using \texttt{createDispatch(portName, SOAPMessage.class, Service.Mode.MESSAGE)} the response and the request would both be \texttt{SOAPMessage} objects.

\textbf{Tips:} 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.
The code below makes a synchronous invocation on a remote service using a DOMSource object.

```java
// Creating a DOMSource Object for the request
DocumentBuilder db = DocumentBuilderFactory.newInstance().newDocumentBuilder();
Document requestDoc = db.newDocument();
root.setTextValue("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 Chapter 4, 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.

```java
Response<T> invokeAsync(T msg)
throws WebServiceException;
```

When using the callback approach the `invokeAsync()` method takes an `AsyncHandler` implementation that processes the response when it is returned.

```java
Future<?> invokeAsync(T msg, AsyncHandler<T> handler)
throws WebServiceException;
```

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()`.

```java
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.

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.
The code below makes a one way invocation on a remote service using a JAXB object.

```java
// Creating a JAXBContext and an Unmarshaller for the request
JAXBContext jbc = JAXBContext.newInstance("org.mycompany.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);
```

**Operation Determination**

When using a Dispatch client with a WSDL file, the operation name will be set under one of the following cases.

- The javax.xml.ws.handler.MessageContext.WSDL_OPERATION property of the request context is set with the operation QName.

- The addressing feature is enabled (in the bus or at the endpoint) and there is a matching operation to the payload element.

- The "find.dispatch.operation" property of the request context is set to Boolean.TRUE and there is a matching operation to the payload element. This property is not set by default. Determining the correct operation will affect the processing such as setting the correct SOAPAction or WS-Addressing’s Action.

**2.3.7. Developing a Consumer**

**2.3.7.1. Generating the Stub Code**

The starting point for developing a service consumer (or client) in CXF is a WSDL contract, complete with port type, binding, and service definitions. You can then use the wsdl2java utility to generate the Java stub code from the WSDL contract. The stub code provides the supporting code that is required to invoke operations on the remote service. For CXF clients, the wsdl2java utility can generate the following kinds of code:

- Stub code - supporting files for implementing a CXF client.

- Client starting point code - sample client 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 client application.
Basic HelloWorld WSDL contract

The below shows the HelloWorld WSDL contract. This contract defines a single port type, Greeter, with a SOAP binding, Greeter_SOAPBinding, and a service, SOAPService, which has a single port, SoapPort.

```xml
<?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"
            xmlns:tns="http://apache.org/hello_world_soap_http/types"
            elementFormDefault="qualified">
            <simpleType name="MyStringType">
                <restriction base="string">
                    <maxLength value="30" />
                </restriction>
            </simpleType>
            <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="tns:MyStringType"/>
                    </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>
        </schema>
    </wsdl:types>
</wsdl:definitions>
```
<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: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">
  <wsdl:operation name="sayHi">
    <wsdl:input message="tns:sayHiRequest" name="sayHiRequest"/>
    <wsdl:output message="tns:sayHiResponse" name="sayHiResponse"/>
  </wsdl:operation>

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

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

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

  <wsdl:operation name="pingMeFault">
    <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>
The Greeter port type from the example above [44] defines the following WSDL operations:

- **sayHi** - has a single output parameter, of `xsd:string`.
- **greetMe** - has an input parameter, of `xsd:string`, and an output parameter, of `xsd:string`. 
• greetMeOneWay - has a single input parameter, of xsd:string. Because this operation has no output parameters, CXF can optimize this call to be a oneway invocation (that is, the client does not wait for a response from the server).

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

The above example also defines a binding, Greeter_SOAPBinding, for the SOAP protocol. In practice, the binding is normally generated automatically - for example, by running either of the CXF wsdl2soap or wsdl2xml utilities. Likewise, the SOAPService service can be generated automatically by running the CXF wsdl2service utility.

Generating the stub code

After defining the WSDL contract, you can generate client code using the CXF wsdl2java utility. Enter the following command at a command-line prompt:

```
wsdl2java -client -d ClientDir hello_world.wsdl
```

Where ClientDir 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 the above WSDL. The -client option generates starting point code for a client main() method.

The preceding wsdl2java 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 the wsdl2java command 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 port type. In JAX-WS terminology, this Java interface is a service endpoint interface.

  • SOAPService is a Java class 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.apache.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.
2.3.7.2. Implementing a CXF Client

This section describes how to write the code for a simple Java client, based on the WSDL contract above. To implement the client, you need to use the following stub classes:

- Service class (that is, SOAPService).
- Service endpoint interface (that is, Greeter).

Generated service class

The next example shows the typical outline a generated service class, ServiceName, which extends the javax.xml.ws.Service base class.

Example 2.9. Outline of a Generated Service Class

```java
public class ServiceName extends javax.xml.ws.Service {

    ...

    public ServiceName(URL wsdlLocation, QName serviceName) {} 
    public ServiceName() {}
    public Greeter getPortName() {}

    ...
}
```

The ServiceName class above 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`.
  - `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 the CXF wsdl2java command). Using this constructor presupposes that the WSDL contract remains available at its original location.
  - `get_PortName_()` methods - for every PortName port defined on the ServiceName service, CXF generates a corresponding `get_PortName_()` method in Java. Therefore, a `wsdl:service` element that defines multiple ports will generate a service class with multiple `get_PortName_()` methods.

Service endpoint interface

For every port type defined in the original WSDL contract, you can generate a corresponding service endpoint interface in Java. A service endpoint interface is the Java mapping of a WSDL port type. Each operation defined in the original WSDL port type maps to a corresponding method in the service endpoint interface. 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).

The next example shows the Greeter service endpoint interface, which is generated from the Greeter port type defined in the WSDL above. For simplicity, this example omits the standard JAXB and JAX-WS annotations.

Example 2.10. The Greeter Service Endpoint Interface

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

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

Client main function

This example shows the Java code that implements the HelloWorld client. In summary, the client connects to the SoapPort port on the SOAPService service and then proceeds to invoke each of the operations supported by the Greeter port type.

```java
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 {
        if (args.length == 0) {
            System.out.println("please specify wsdl");
            System.exit(1);
        }

        URL wsdlURL;
        File wsdlFile = new File(args[0]);
        if (wsdlFile.exists()) {
            wsdlURL = wsdlFile.toURL();
        }...
```
The `Client.main()` function from the above example proceeds as follows:

1. The CXF runtime is implicitly initialized - that is, provided the CXF runtime classes are loaded. Hence, there is no need to call a special function in order to initialize CXF.

2. The client expects a single string argument that gives the location of the WSDL contract for `HelloWorld`. The WSDL location is stored in `wsdlURL`.

3. A new port object (which enables you to access the remote server endpoint) is created in two steps, as shown in the following code fragment:

```java
SOAPService ss = new SOAPService(wsdlURL, SERVICE_NAME);
Greeter port = ss.getSoapPort();
```

To create a new port object, you first create a service object (passing in the WSDL location and service name) and then 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.

4. The client proceeds to call each of the methods supported by the `Greeter` service endpoint interface.

5. In the case of the `pingMe()` operation, the example code shows how to catch the `PingMeFault` fault exception.
2.3.7.3. Setting Connection Properties with Contexts

You can use JAX-WS contexts to customize the properties of a client proxy. In particular, contexts can be used to modify connection properties and to send data in protocol headers. For example, you could use contexts to add a SOAP header, either to a request message or to a response message. The following types of context are supported on the client side:

- **Request context** - on the client side, 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** - on the client side, you can access the response context to read the property values set by the inbound message from the last operation invocation. 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.

### Setting a request context

To set a particular request context property, `ContextPropertyName`, to the value, `PropertyValue`, use the code shown in the below example.

**Example 2.11. Setting a Request Context Property on the Client Side**

```java
// Set request context property.
java.util.Map<String, Object> requestContext =
    ((javax.xml.ws.BindingProvider)port).getRequestContext();
requestContext.put(ContextPropertyName, PropertyValue);

// Invoke an operation.
port.SomeOperation();
```

You have to cast the port object to `javax.xml.ws.BindingProvider` in order to access the request context. The request context itself is of type, `java.util.Map<String, Object>`, which is a hash map that has keys of `String` and values of arbitrary type. Use `java.util.Map.put()` to create a new entry in the hash map.

### Reading a response context

To retrieve a particular response context property, `ContextPropertyName`, use the code shown below.

**Example 2.12. Reading a Response Context Property on the Client Side**

```java
// 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);

The response context is of type, java.util.Map<String, Object>, which is a hash map that
has keys of type String and values of an arbitrary type. Use java.util.Map.get() to access an
entry in the hash map of response context properties.

**Supported contexts**

CXF supports the following context properties:

<table>
<thead>
<tr>
<th>Context Property Name</th>
<th>Context Property Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>org.apache.cxf.ws.addressing.org.apache.cxf.ws.addressing.JAXWSAConstants.CLIENT_ADDRESSING_PROPERTIES</td>
<td>AddressingProperties</td>
</tr>
</tbody>
</table>

**2.3.7.4. Asynchronous Invocation Model**

In addition to the usual synchronous mode of invocation, CXF also supports two forms of
asynchronous invocation, as follows:

- **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 instance. The Response
  object (which inherits from the javax.util.concurrent.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 CXF runtime
  calls back on the AsyncHandler object to give it the contents of the response message.

Both of these asynchronous invocation approaches are described here and illustrated by code
examples.

**Contract for asynchronous example**

The below example shows the WSDL contract that is used for the asynchronous example.
The contract defines a single port type, GreeterAsync, which contains a single operation,
greetMeSometime.

```xml
<wsdl:definitions xmlns="http://schemas.xmlsoap.org/wsdl/
    xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
    xmlns:tns="http://apache.org/hello_world_async_soap_http"
    xmlns:xl="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"
Generating the asynchronous stub code

The asynchronous style of invocation requires extra stub code (for example, dedicated asynchronous methods defined on the service endpoint interface). 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.

Customization enables you to modify the way the wsdl2java utility 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 the wsdl2java utility 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 first approach, the external binding declaration. The template for a binding declaration file that switches on asynchronous invocations is shown below.

**Example 2.13. Template for an Asynchronous Binding Declaration**

```xml
<bindings xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
    wsdlLocation="@WSDL_LOCATION@/hello_world_async.wsdl"
    xmlns="http://java.sun.com/xml/ns/jaxws">
    <bindings node="wsdl:definitions">
        <enableAsyncMapping>true</enableAsyncMapping>
    </bindings>
</bindings>
```

Where *AffectedWSDLContract* 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 port type, you could specify `<bindings node="wsdl:definitions/wsdl:portType[@name='GreeterAsync']">` in the preceding binding declaration.

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 wsdl2java command:

```
wsdl2java -client -d ClientDir -b async_binding.xml hello_world.wsdl
```

When you run the wsdl2java command, you specify the location of the binding declaration file using the -b option. After generating the stub code in this way, the GreeterAsync service endpoint interface (in the file *GreeterAsync.java*) is defined as shown below.

**Example 2.14. Service Endpoint Interface with Methods for Asynchronous Invocations**

```java
/* Generated by WSDLToJava Compiler. */
```
In addition to the usual synchronous method, `greetMeSometime()`, two asynchronous methods are also generated for the `greetMeSometime` operation, as follows:

- `greetMeSometimeAsync()` method with `Future<?>` return type and an extra `javax.xml.ws.AsyncHandler` parameter - call this method for the callback approach to asynchronous invocation.

- `greetMeSometimeAsync()` method with `Response<GreetMeSometimeResponse>` return type - call this method for the polling approach to asynchronous invocation.

The details of the callback approach and the polling approach are discussed in the following subsections.

### Implementing an asynchronous client with the polling approach

The next example illustrates the polling approach to making an asynchronous operation call. Using this approach, the client invokes the operation by calling the special Java method, `_OperationName_Async()`, that returns a `javax.xml.ws.Response<T>` object, where `T` is the type of the operation’s response message. The `Response<T>` object can be polled at a later stage to check whether the operation’s response message has arrived.

#### Example 2.15. Polling Approach for an Asynchronous Operation Call

```java
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_async_soap_http.GreeterAsync;
import org.apache.hello_async_soap_http.SOAPService;
import org.apache.hello_async_soap_http.types.GreetMeSometimeResponse;

public final class Client {

```
```
private static final QName SERVICE_NAME
    = new QName("http://objectweb.org/hello_async_soap_http",
               "SOAPService");

private static Client() {}

public static void main(String[] args) throws Exception {
    // Polling approach:
    Response<GreetMeSometimeResponse> greetMeSomeTimeResp =
        port.greetMeSometimeAsync(System.getProperty("user.name"));
    while (!greetMeSomeTimeResp.isDone()) {
        Thread.sleep(100);
    }
    GreetMeSometimeResponse reply = greetMeSomeTimeResp.get();
    ...
    System.exit(0);
}

The **greetMeSometimeAsync()** method invokes the **greetMeSometimes** operation, transmitting the input parameters to the remote service and returning a reference to a **javax.xml.ws.Response** object. The **Response** class is defined by extending the standard **java.util.concurrent.Future<T>** interface, which is specifically designed for polling the outcome of work performed by a concurrent thread. There are essentially two basic approaches to polling using the **Response** object:

- **Non-blocking polling** - before attempting to get the result, check whether the response has arrived by calling the non-blocking **Response<T>.isDone()** method. For example:

  ```java
  Response<GreetMeSometimeResponse> greetMeSomeTimeResp = ...;
  if (greetMeSomeTimeResp.isDone()) {
      GreetMeSometimeResponse reply = greetMeSomeTimeResp.get();
  }
  ```

- **Blocking polling** - call **Response<T>.get()** right away and block until the response arrives (optionally specifying a timeout). For example, to poll for a response, with a 60 second timeout:

  ```java
  Response<GreetMeSometimeResponse> greetMeSomeTimeResp = ...;
  GreetMeSometimeResponse reply = greetMeSomeTimeResp.get(60L,
               java.util.concurrent.TimeUnit.SECONDS);
  ```

### Implementing an asynchronous client with the callback approach

An alternative approach to making an asynchronous operation invocation is to implement a callback class, by deriving from the **javax.xml.ws.AsyncHandler** interface. This callback class must implement a **handleResponse()** method, which is called by the CXF runtime to notify the client that the response has arrived. The below example shows an outline of the **AsyncHandler** interface that you need to implement.

**Example 2.16. The javax.xml.ws.AsyncHandler Interface**

```java
package javax.xml.ws;
```
In this example, a callback class, `TestAsyncHandler`, is defined as shown in the example below.

**Example 2.17. The TestAsyncHandler Callback Class**

```java
package demo.hw.client;

import javax.xml.ws.AsyncHandler;
import javax.xml.ws.Response;
import org.apache.hello_async_soap.types.GreetMeSometimeResponse;

public class TestAsyncHandler implements AsyncHandler<GreetMeSometimeResponse> {
    private GreetMeSometimeResponse reply;

    public void handleResponse(Response<GreetMeSometimeResponse> response) {
        try {
            reply = response.get();
        } catch (Exception ex) {
            ex.printStackTrace();
        }
    }

    public String getResponse() {
        return reply.getResponseType();
    }
}
```

The implementation of `handleResponse()` shown in Example 11 [57] simply gets the response data and stores it in a member variable, `reply`. The extra `getResponse()` method is just a convenience method that extracts the sole output parameter (that is, `responseType`) from the response.

Example 12 [57] illustrates the callback approach to making an asynchronous operation call. Using this approach, the client invokes the operation by calling the special Java method, `_OperationName_Async()`, that returns a `java.util.concurrent.Future<?>` object and takes an extra parameter of `AsyncHandler<T>`.

**Example 2.18. Callback Approach for an Asynchronous Operation Call**

```java
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_async_soap_http.GreeterAsync;
import org.apache.hello_async_soap_http.SOAPService;
import org.apache.hello_async_soap_http.types.GreetMeSometimeResponse;
```
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 {
        ...
        // Callback approach
        TestAsyncHandler testAsyncHandler = new TestAsyncHandler();
        System.out.println("Invoking greetMeSometimeAsync using callback object...");
        Future<?> response = port.greetMeSometimeAsync(System.getProperty("user.name"), testAsyncHandler);
        while (!response.isDone()) {
            Thread.sleep(100);
        }
        resp = testAsyncHandler.getResponse();
        ...
        System.exit(0);
    }
}

The `Future<?>` object returned by `greetMeSometimeAsync()` can be used only to test whether or not a response has arrived yet - for example, by calling `response.isDone()`. The value of the response is only made available to the callback object, `testAsyncHandler`.

### 2.4. Data Binding Options

CXF uses JAXB 2.2 as its default databinding. JAXB is most commonly used for web services and will be covered in this section along with alternative XMLBeans and SDO databinding. CXF also supports the Aegis data binding, which originated with CXF’s precursor XFire and is covered on the [CXF website](http://cxf.apache.org/).

#### 2.4.1. JAXB

JAXB is the default data binding for CXF. If you don’t specify one of the other data bindings in your Spring configuration or through the API, you will get JAXB. Releases of CXF since 2.3.x have used the JDK7 default of JAXB 2.2, however Maven users running on JDK 6 will need to use the Java endorsed override mechanism to use JAXB 2.2 instead of JAXB 2.1.

JAXB uses Java annotation combined with files found on the classpath to build the mapping between XML and Java. JAXB supports both code-first and schema-first programming. Schema-first supports the ability to create a client proxy, dynamically, at runtime. See the CXF [DynamicClientFactory class](http://cxf.apache.org/).

CXF uses the JAXB reference implementation. To learn more about annotating your classes or how to generate beans from a schema, please read the [JAXB user’s guide](http://cxf.apache.org/).
2.4.1.1. JAXB versus JAX-WS (or other front-ends)

There are some pitfalls in the interaction between the front end and the data binding. If you need detailed control over the XML that travels on the wire, you may want to avoid the ‘wrapped’ alternative, and stick with ‘bare’. When you use the wrapped parameter style or the RPC binding, the front ends construct more or less elaborate XML representations for your operations. You have less control over those constructs than you do over JAXB’s mappings. In particular, developers with detailed requirements to control the XML Schema ‘elementFormDefault’ or the use or non-use of XML namespace prefixes often become frustrated because the JAXB annotations for these options don’t effect mappings that are purely the work of the front-end. The safest course is to use Document/Literal/Bare.

2.4.1.2. Configuring JAXB

CXF allows you to configure JAXB in two ways.

JAXB Properties

JAXB allows the application to specify two sets of properties that modify its behavior: context properties and marshaller properties. CXF allows applications to add to these properties. Take care. In some cases, CXF sets these properties for its own use.

You can add items to both of these property sets via the JAXBDataBinding class. The ‘contextProperties’ and ‘marshallerProperties’ properties (in the Spring sense) of JAXBDataBinding each store a Map<String, Object>. Whatever you put in the map, CXF will pass along to JAXB. See the JAXB documentation for details.

Example 2.19. Example of Configuring a Context Property

```xml
<jaxws:server id="bookServer"
    serviceClass="org.apache.cxf.mytype.AnonymousComplexTypeImpl"
    address="http://localhost:8080/act"
    bus="cxf">
    <jaxws:invoker>
        <bean class="org.apache.cxf.service.invoker.BeanInvoker">
            <constructor-arg>
                <bean class="org.apache.cxf.mytype.AnonymousComplexTypeImpl"/>
            </constructor-arg>
        </bean>
    </jaxws:invoker>
    <jaxws:dataBinding>
        <bean class="org.apache.cxf.jaxb.JAXBDataBinding">
            <property name="contextProperties">
                <map>
                    <entry>
                        <key>com.sun.xml.bind.defaultNamespaceRemap</key>
                        <value>uri:ultima:thule</value>
                    </entry>
                </map>
            </property>
        </bean>
    </jaxws:dataBinding>
</jaxws:server>
```
Activating JAXB Validation of SOAP requests and responses

For the client side

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

You may also do this programmatically:

```java
((BindingProvider)port).getRequestContext().put(
        "schema-validation-enabled", "true");
```

For the server side

```xml
<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>
```

You can also use the `org.apache.cxf.annotations.SchemaValidation` annotation.

Namespace Prefix Management

The JAXB reference implementation allows the application to provide an object that in turn
maps namespace URI's to prefixes. You can create such an object and supply it via the
marshaller properties. However, CXF provides an easier process. The namespaceMap property of
the `JAXBDataBinding` accepts a `Map<String, String>`. Think of it as a map from namespace URI
to namespace prefix. If you load up this map, CXF will set up the necessary marshaller property
for you.

Example 2.20. Example of Configuring a Namespace Mapping

```xml
<jaxws:server id="bookServer"
    serviceClass="org.apache.cxf.mytype.AnonymousComplexTypeImpl"
    address="http://localhost:8080/act"
    bus="cxf">
    <jaxws:invoker>
        <bean class="org.apache.cxf.service.invoker.BeanInvoker">
            <constructor-arg>
                <bean class="org.apache.cxf.mytype.AnonymousComplexTypeImpl"/>
            </constructor-arg>
        </bean>
    </jaxws:invoker>
</jaxws:server>
```
2.4.2. MTOM Attachments with JAXB

MTOM is a standard which allows your services to transfer binary data efficiently and conveniently. Many frameworks have support for MTOM - Axis2, JAX-WS RI, JBoss WS, XFire, Microsoft's WCF, and more.

If the binary is part of the XML document, it needs to be base64 encoded - taking CPU time and increasing the payload size. When MTOM is enabled on a service, it takes binary data which might normally be part of the XML document, and creates an attachment for it.

Enabling MTOM is a rather simple process. First, you must annotate your schema type or POJO to let JAXB know that a particular field could be a candidate for MTOM optimization. Second, you just tell CXF that you wish to enable MTOM.

This page tells you how to activate MTOM for JAXB. MTOM is also supported in Aegis.

2.4.2.1. 1) Annotating the Message

1a) Modifying your schema for MTOM

Let's say we have a Picture schema type like this:

```xml
<schema targetNamespace="http://pictures.com"
     xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <element name="Picture">
    <complexType>
      <sequence>
        <element name="Title" type="xsd:string"/>
        <element name="ImageData" type="xsd:base64Binary"/>
      </sequence>
    </complexType>
  </element>
</schema>
```
In this case the ImageData element is something we would like to have transferred as an attachment. To do this we just need to add an xmime:expectedContentTypes annotation:

```xml
<schema targetNamespace="http://pictures.com"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xmime="http://www.w3.org/2005/05/xmlmime">
  <element name="Picture">
    <complexType>
      <sequence>
        <element name="Title" type="xsd:string"/>
        <element name="ImageData" type="xsd:base64Binary"
          xmime:expectedContentTypes="application/octet-stream"/>
      </sequence>
    </complexType>
  </element>
</schema>
```

This tells JAXB (which WSDL2Java uses to generate POJOs for your service) that this field could be of any content type. Instead of creating a byte[] array for the base64Binary element, it will create a DataHandler instead which can be used to stream the data.

### 1b) Annotation your JAXB beans to enable MTOM

If you’re doing code first, you need to add an annotation to your POJO to tell JAXB that the field is a candidate for MTOM optimization. Let’s say we have a Picture class with has Title and ImageData fields, then it might look like this:

```java
@XmlType
public class Picture {
  private String title;

  @XmlMimeType("application/octet-stream")
  private DataHandler imageData;

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

  public DataHandler getImageData() { return imageData; }
  public void setImageData(DataHandler imageData)
  { this.imageData = imageData; }
}
```

Note the use of ‘application/octet-stream’. According to the standard, you should be able to use any MIME type you like, in order to specify the actual content of the attachment. However, due to a defect in the JAX-B reference implementation, this won’t work.

### 2.4.2.2. 2) Enable MTOM on your service

If you’ve used JAX-WS to publish your endpoint you can enable MTOM like so:

```java
import javax.xml.ws.Endpoint;
import javax.xml.ws.soap.SOAPBinding;

Endpoint ep = Endpoint.publish("http://localhost/myService",
    new MyService());
```
SOAPBinding binding = (SOAPBinding) ep.getBinding();
binding.setMTOMEnabled(true);

Or, if you used XML to publish your endpoint:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:jaxws="http://cxf.apache.org/jaxws"
    xsi:schemaLocation="
        http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
        http://cxf.apache.org/jaxws
        http://cxf.apache.org/schema/jaxws.xsd">
    <jaxws:endpoint
        id="helloWorld"
        implementor="demo.spring.HelloWorldImpl"
        address="http://localhost/HelloWorld">
        <jaxws:properties>
            <entry key="mtom-enabled" value="true"/>
        </jaxws:properties>
    </jaxws:endpoint>
</beans>
```

If you’re using the simple frontend you can set the mtom-enabled property on your ServerFactoryBean or ClientProxyFactoryBean:

```java
Map<String, Object> props = new HashMap<String, Object>();
// Boolean.TRUE or "true" will work as the property value here
props.put("mtom-enabled", Boolean.TRUE);

ClientProxyFactoryBean pf = new ClientProxyFactoryBean();
pf.setProperties(props);
...
YourClient client = (YourClient) pf.create();

ServerFactoryBean sf = new ServerFactoryBean();
sf.setProperties(props);
...
sf.create();
```

Similarly, you can use the XML configuration:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:simple="http://cxf.apache.org/simple"
    xsi:schemaLocation="
        http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
        http://cxf.apache.org/simple
        http://cxf.apache.org/schema/simple.xsd">
    <simple:server
        id="helloWorld"
        serviceClass="demo.spring.HelloWorldImpl"
        address="http://localhost/HelloWorld">
        <simple:properties>
            <entry key="mtom-enabled" value="true"/>
        </simple:properties>
    </simple:server>
</beans>
```
2.4.2.3. Using DataHandlers

Once you've got the above done, it's time to start writing your logic. DataHandlers are easy to use and create. To consume a DataHandler:

```java
Picture picture = ...;
DataHandler handler = picture.getImageData();
InputStream is = handler.getInputStream();
```

There are many ways to create DataHandlers. You can use a FileDataSource, ByteArrayDataSource, or write your own DataSource:

```java
DataSource source = new ByteArrayDataSource(new byte[...], "content/type");
DataSource source = new FileDataSource(new File("my/file"));
Picture picture = new Picture();
picture.setImageData(new DataHandler(source));
```

2.4.3. SDO

Apache CXF 2.3 added support for the Tuscany implementation of Service Data Objects as alternative data binding.

2.4.3.1. Setup

By default, CXF does not ship with the Tuscany SDO jars. You will need to acquire them elsewhere and add them to the classpath for the SDO databinding to work. The list of required jars are:

```java
backport-util-concurrent-3.0.jar
codegen-2.2.3.jar
codegen-ecore-2.2.3.jar
common-2.2.3.jar
ecore-2.2.3.jar
ecore-change-2.2.3.jar
ecore-xmi-2.2.3.jar
tuscany-sdo-api-r2.1-1.1.1.jar
tuscany-sdo-impl-1.1.1.jar
tuscany-sdo-lib-1.1.1.jar
tuscany-sdo-tools-1.1.1.jar	xsd-2.2.3.jar
```
2.4.3.2. Code Generation

If all the SDO required jars are available (by default, CXF does not ship them, see above), wsld2java tool can be run with the -db sdo flag to have the code generator emit SDO objects instead of the default JAXB objects. The generated SEI interface will have @DataBinding(org.apache.cxf.sdo.SDODataBinding.class) annotation on it which is enough to configure the runtime to know to use SDO.

2.4.4. XMLBeans

Apache XMLBeans is another technology for mapping XML Schema to java objects. CXF added support for XMLBeans in 2.1. There are a two parts to the support for XMLBeans:

2.4.4.1. Code Generation

The wsdl2java tool now allows a "-db xmlbeans" flag to be added that will generate XMLBeans types for all the schema beans instead of the default JAXB beans. With 2.1 and 2.2, the types are generated, but you still need to configure the XMLBeans databinding to be used at runtime. With 2.3, the generated code contains an @Databinding annotation marking it as XMLBeans and the configuration is unnecessary.

2.4.4.2. Runtime

You need to configure the runtime to tell it to use XMLBeans for the databinding instead of JAXB.

Spring config

For the server side, your spring configuration would contain something like:

```xml
<jaxws:server serviceClass="demo.hw.server.HelloWorld"
  address="/hello_world">
  <jaxws:dataBinding>
    <bean class="org.apache.cxf.xmlbeans.XmlBeansDataBinding" />
  </jaxws:dataBinding>
</jaxws:server>
```

or

```xml
<jaxws:endpoint
  id="HelloWorld"
  implementor="demo.spring.HelloWorldImpl"
  address="http://localhost/HelloWorld">
  <jaxws:dataBinding>
    <bean class="org.apache.cxf.xmlbeans.XmlBeansDataBinding" />
  </jaxws:dataBinding>
</jaxws:endpoint>
```
The client side is very similar:

```xml
<jaxws:client id="helloClient"
  serviceClass="demo.spring.HelloWorld"
  address="http://localhost:9002/HelloWorld">
  <jaxws:dataBinding>
    <bean class="org.apache.cxf.xmlbeans.XmlBeansDataBinding" />
  </jaxws:dataBinding>
</jaxws:client>
```

**FactoryBeans**

If using programmatic factory beans instead of spring configuration, the databinding can be set on the `ClientProxyFactoryBean` (and subclasses) and the `ServerFactoryBean` (and subclasses) via:

```java
factory.getServiceFactory().setDataBinding(
    new org.apache.cxf.xmlbeans.XmlBeansDataBinding());
```

### 2.5. CXF Transports

#### 2.5.1. HTTP Transport

HTTP transport support via servlet-based environments is described below (embedded Jetty and OSGi deployment is also available in CXF).

#### 2.5.1.1. Client HTTP Transport (including SSL support)

**Configuring SSL Support**

To configure your client to use SSL, you'll need to add an `<http:conduit>` definition to your XML configuration file. If you are already using Spring, this can be added to your existing beans definitions.

A [wsdl_first_https](#) sample can be found in the CXF distribution with more detail. Also, if desired, you can encrypt any temporary files created by CXF during large data stream caching -- see the [CXF documentation](#) for more details.

Here is a sample of what your conduit definition might look like:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:sec="http://cxf.apache.org/configuration/security"
       xmlns:http="http://cxf.apache.org/transports/http/configuration"
       xmlns:jaxws="http://java.sun.com/xml/ns/jaxws"
```
The first thing to notice is the "name" attribute on <http:conduit>. This allows CXF to associate this HTTP Conduit configuration with a particular WSDL Port. The name includes the service's namespace, the WSDL port name (as found in the wsdl:service section of the WSDL), and "http-conduit". It follows this template: "{WSDL Namespace}portName.http-conduit". Note: it's the PORT name, not the service name. Thus, it's likely something like "MyServicePort", not "MyService". If you are having trouble getting the template to work, another (temporary) option for the name value is simply "*.http-conduit".

Another option for the name attribute is a reg-ex expression (e.g., "http://localhost:"*) for the ORIGINAL URL of the endpoint. The configuration is matched at conduit creation so the address used in the WSDL or used for the JAX-WS Service.create(...) call can be used for the name. For example, you can do:

```xml
<http:conduit name="http://localhost:8080/.*">
  ...
</http:conduit>
```
to configure a conduit for all interactions on localhost:8080. If you have multiple clients interacting with different services on the same server, this is probably the easiest way to configure it.

If your service endpoint uses an SSL WSDL location (i.e., "https://xxx?wsdl"), you can configure the http conduit to pick up the SSL configuration by using a hardcoded http conduit name of 
"[http://cxf.apache.org/]TransportURIResolver.http-conduit". The specific HTTP conduit name or a reg-ex expression can still be used.

Keystores (as identified by the sec:keyStore element above) can be identified via any one of three ways: via a file, resource, or url attribute. File locations are either an absolute path or relative to the working directory, the resource attribute is relative to the classpath, and URLs must be a valid URL such as "http://..." "file:///...", etc. Only one attribute of "url", "file", or "resource" is allowed.

**Advanced Configuration**

HTTP client endpoints can specify a number of HTTP connection attributes including whether the endpoint automatically accepts redirect responses, whether the endpoint can use chunking, whether the endpoint will request a keep-alive, and how the endpoint interacts with proxies.

A client endpoint can be configured using three mechanisms:

- Configuration
- WSDL
- Java code

**Using Configuration**

**Namespace**

The elements used to configure an HTTP client are defined in the namespace http://cxf.apache.org/transports/http/configuration". It is commonly referred to using the prefix http-conf. In order to use the HTTP configuration elements you will need to add the lines shown below to the beans element of your endpoint's configuration file. In addition, you will need to add the configuration elements' namespace to the xsi:schemaLocation attribute.

**Example 2.21. HTTP Consumer Configuration Namespace**

```xml
<beans ... 
    xmlns:http-conf="http://cxf.apache.org/transports/http/configuration ... 
```
The conduit element

You configure an HTTP client using the http-conf:conduit element and its children. The http-conf:conduit element takes a single attribute, name, that specifies the WSDL port element that corresponds to the endpoint. The value for the name attribute takes the form portQName.http-conduit. For example, the code below shows the http-conf:conduit element that would be used to add configuration for an endpoint that was specified by the WSDL fragment <port binding="widgetSOAPBinding" name="widgetSOAPPort"> if the endpoint's target namespace was http://widgets.widgetvendor.net. Alternatively, the name attribute can be a regular expression to match a URL. This allows configuration of conduits that are not used for purposes of WSDL based endpoints such as JAX-RS and for WSDL retrieval.

Example 2.22. http-conf:conduit Element examples

```xml
<http-conf:conduit name="{http://widgets/widgetvendor.net}widgetSOAPPort.http-conduit">
   ...
</http-conf:conduit>

<http-conf:conduit name="*.http-conduit">
   <!-- you can also using a wild card specify the http-conduit that you want to configure -->
   ...
</http-conf:conduit>

<http-conf:conduit name="http://localhost:8080/.">
   <!-- you can also use the reg-ex URL to match for the http-conduit that you want to configure -->
   ...
</http-conf:conduit>

<http-conf:conduit name="http://localhost:8080/.*">
   <!-- you can also using the reg-ex URL matching for the http-conduit that you want to configure -->
   ...
</http-conf:conduit>
```

The http-conf:conduit element has a number of child elements that specify configuration information. They are described below. See also Sun’s JSSE Guide for more information on configuring SSL.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>http-conf:client</td>
<td>Specifies the HTTP connection properties such as timeouts, keep-alive requests, content types, etc.</td>
</tr>
<tr>
<td>http-conf:authorization</td>
<td>Specifies the the parameters for configuring the basic authentication method that the endpoint uses preemptively.</td>
</tr>
<tr>
<td>http-conf:proxyAuthorization</td>
<td>Specifies the parameters for configuring basic authentication against outgoing HTTP proxy servers.</td>
</tr>
<tr>
<td>http-conf:tlsClientParameters</td>
<td>Specifies the parameters used to configure SSL/TLS.</td>
</tr>
<tr>
<td>http-conf:authSupplier</td>
<td>Specifies the bean reference or class name of the object that supplies the authentication information used by the endpoint both preemptively or in response to a 401 HTTP challenge.</td>
</tr>
<tr>
<td>http-conf:trustDecider</td>
<td>Specifies the bean reference or class name of the object that checks the HTTP(S) URLConnection object in order</td>
</tr>
</tbody>
</table>
The client element

The `http-conf:client` element is used to configure the non-security properties of a client's HTTP connection. Its attributes, described below, specify the connection's properties.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ConnectionTimeout</td>
<td>Specifies the amount of time, in milliseconds, that the client will attempt to establish a connection before it times out. The default is 30000 (30 seconds). 0 specifies that the client will continue to attempt to open a connection indefinitely.</td>
</tr>
<tr>
<td>ReceiveTimeout</td>
<td>Specifies the amount of time, in milliseconds, that the client will wait for a response before it times out. The default is 60000. 0 specifies that the client will wait indefinitely.</td>
</tr>
<tr>
<td>AutoRedirect</td>
<td>Specifies if the client will automatically follow a server issued redirection. The default is false.</td>
</tr>
<tr>
<td>MaxRetransmits</td>
<td>Specifies the maximum number of times a client will retransmit a request to satisfy a redirect. The default is -1 which specifies that unlimited retransmissions are allowed.</td>
</tr>
</tbody>
</table>
| AllowChunking      | Specifies whether the client will send requests using chunking. The default is true which specifies that the client will use chunking when sending requests. Chunking cannot be used used if either of the following are true:
  - `http-conf:basicAuthSupplier` is configured to provide credentials preemptively.
  - `AutoRedirect` is set to true. In both cases the value of AllowChunking is ignored and chunking is disallowed. See note about chunking below. |
| ChunkingThreshold  | Specifies the threshold at which CXF will switch from non-chunking to chunking. By default, messages less than 4K are buffered and sent non-chunked. Once this threshold is reached, the message is chunked. |
| Accept             | Specifies what media types the client is prepared to handle. The value is used as the value of the HTTP `Accept` property. The value of the attribute is specified using as multipurpose internet mail extensions (MIME) types. See note about chunking below. |
| AcceptLanguage     | Specifies what language (for example, American English) the client prefers for the purposes of receiving a response. The value is used as the value of the HTTP `AcceptLanguage` property. Language tags are regulated by the International Organization for Standards (ISO) and are typically formed by combining a language code, determined by the ISO-639 standard, and country code, determined by the ISO-3166 standard, separated by a hyphen. For example, en-US represents American English. |
| AcceptEncoding     | Specifies what content encodings the client is prepared to handle. Content encoding labels are regulated by the Internet Assigned Numbers Authority (IANA). The value is used as the value of the HTTP `AcceptEncoding` property. |
| ContentType        | Specifies the media type of the data being sent in the body of a message. Media types are specified using multipurpose internet mail extensions (MIME) types. The value is used as the value of the HTTP `ContentType` property. The default is `text/xml`. **Tip:** For web services, this should be set to `text/xml`. If the client is sending HTML form data to a CGI script, this should be set to `application/x-www-form-urlencoded`. If the HTTP POST
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host</td>
<td>Specifies the Internet host and port number of the resource on which the request is being invoked. The value is used as the value of the HTTP Host property. <strong>Tip:</strong> This attribute is typically not required. It is only required by certain DNS scenarios or application designs. For example, it indicates what host the client prefers for clusters (that is, for virtual servers mapping to the same Internet protocol (IP) address).</td>
</tr>
<tr>
<td>Connection</td>
<td>Specifies whether a particular connection is to be kept open or closed after each request/response dialog. There are two valid values: • <strong>Keep-Alive</strong> (default) specifies that the client wants to keep its connection open after the initial request/response sequence. If the server honors it, the connection is kept open until the consumer closes it. • <strong>close</strong> specifies that the connection to the server is closed after each request/response sequence.</td>
</tr>
<tr>
<td>CacheControl</td>
<td>Specifies directives about the behavior that must be adhered to by caches involved in the chain comprising a request from a client to a server.</td>
</tr>
<tr>
<td>Cookie</td>
<td>Specifies a static cookie to be sent with all requests.</td>
</tr>
<tr>
<td>BrowserType</td>
<td>Specifies information about the browser from which the request originates. In the HTTP specification from the World Wide Web consortium (W3C) this is also known as the user-agent. Some servers optimize based upon the client that is sending the request.</td>
</tr>
<tr>
<td>Referer</td>
<td>Specifies the URL of the resource that directed the consumer to make requests on a particular service. The value is used as the value of the HTTP Referer property. <strong>Note:</strong> This HTTP property is used when a request is the result of a browser user clicking on a hyperlink rather than typing a URL. This can allow the server to optimize processing based upon previous task flow, and to generate lists of back-links to resources for the purposes of logging, optimized caching, tracing of obsolete or mistyped links, and so on. However, it is typically not used in web services applications. <strong>Important:</strong> If the AutoRedirect attribute is set to true and the request is redirected, any value specified in the Referer attribute is overridden. The value of the HTTP Referer property will be set to the URL of the service who redirected the consumer's original request.</td>
</tr>
<tr>
<td>DecoupledEndpoint</td>
<td>Specifies the URL of a decoupled endpoint for the receipt of responses over a separate server-&gt;client connection. <strong>Warning:</strong> You must configure both the client and server to use WS-Addressing for the decoupled endpoint to work.</td>
</tr>
<tr>
<td>ProxyServer</td>
<td>Specifies the URL of the proxy server through which requests are routed.</td>
</tr>
<tr>
<td>ProxyServerPort</td>
<td>Specifies the port number of the proxy server through which requests are routed.</td>
</tr>
<tr>
<td>NonProxyHosts</td>
<td>Specifies a list of hosts that should be directly routed. This value is a list of patterns separated by &quot;,&quot;, where each pattern may start or end with a &quot;*&quot; for wildcard matching.</td>
</tr>
<tr>
<td>ProxyServerType</td>
<td>Specifies the type of proxy server used to route requests. Valid values are: • HTTP (default) • SOCKS</td>
</tr>
</tbody>
</table>

request is bound to a fixed payload format (as opposed to SOAP), the content type is typically set to application/octet-stream.
Example using the Client Element

The example below shows a the configuration for an HTTP client that wants to keep its connection to the server open between requests, will only retransmit requests once per invocation, and cannot use chunking streams.

Example 2.23. HTTP Consumer Endpoint Configuration

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:schemaLocation="http://cxf.apache.org/transports/http/configuration
                          http://cxf.apache.org/schemas/configuration/http-conf.xsd
                          http://www.springframework.org/schema/beans
                          http://www.springframework.org/schema/beans/spring-beans.xsd">
    <http-conf:client Connection="Keep-Alive"
                       MaxRetransmits="1"
                       AllowChunking="false" />
  </http-conf:conduit>
</beans>
```

Again, see the Configuration page for information on how to get CXF to detect your configuration file.

The `tlsClientParameters` element

Please see TLS Configuration page for more information.

Using WSDL

Namespace

The WSDL extension elements used to configure an HTTP client are defined in the namespace http://cxf.apache.org/transports/http/configuration. It is commonly referred to using the prefix `http-conf`. In order to use the HTTP configuration elements you will need to add the line shown below to the `definitions` element of your endpoint’s WSDL document.

Example 2.24. HTTP Consumer WSDL Element’s Namespace

```xml
<definitions ...
```

The `client` element

The `http-conf:client` element is used to specify the connection properties of an HTTP client in a WSDL document. The `http-conf:client` element is a child of the WSDL `port` element. It has the same attributes as the `client` element used in the configuration file.
Example

The example below shows a WSDL fragment that configures an HTTP client to specify that it will not interact with caches.

Example 2.25. WSDL to Configure an HTTP Consumer Endpoint

```xml
<service ...>
  <port ...>
    <soap:address ... />
    <http-conf:client CacheControl="no-cache" />
  </port>
</service>
```

Using java code

How to configure the HTTPConduit for the SOAP Client?

First you need get the HTTPConduit from the Proxy object or Client, then you can set the HTTPClientPolicy, AuthorizationPolicy, ProxyAuthorizationPolicy, TLSClientParameters, and/or HttpBasicAuthSupplier.

```java
import org.apache.cxf.endpoint.Client;
import org.apache.cxf.frontend.ClientProxy;
import org.apache.cxf.transport.http.HTTPConduit;
import org.apache.cxf.transports.http.configuration.HTTPClientPolicy;
...

URL wsdl = getClass().getResource("wsdl/greeting.wsdl");
SOAPService service = new SOAPService(wsdl, serviceName);
Greeter greeter = service.getPort(portName, Greeter.class);
// Okay, are you sick of configuration files ?
// This will show you how to configure the http conduit dynamically
Client client = ClientProxy.getClient(greeter);
HTTPConduit http = (HTTPConduit) client.getConduit();
HTTPClientPolicy httpClientPolicy = new HTTPClientPolicy();
httpClientPolicy.setConnectionTimeout(36000);
httpClientPolicy.setAllowChunking(false);
httpClientPolicy.setReceiveTimeout(32000);
http.setClient(httpClientPolicy);
...
greeter.sayHi("Hello");
```

How to override the service address?

If you are using JAXWS API to create the proxy object, here is an example which is complete JAX-WS compliant code
If you are using CXF ProxyFactoryBean to create the proxy object, you can do like this

```java
JaxWsProxyFactoryBean proxyFactory = new JaxWsProxyFactoryBean();
proxyFactory.setServiceClass(ServicePort.class);
// you could set the service address with this method
proxyFactory.setAddress("theUrlyouwant");
ServicePort client = (ServicePort) proxyFactory.create();
```

Here is another way which takes advantage of JAXWS's Service.addPort() API

```java
URL wsdlURL = MyService.class.getClassLoader().getResource("service2.wsdl");
QName serviceName = new QName("urn:service2", "MyService");
QName portName = new QName("urn:service2", "ServicePort");
MyService service = new MyService(wsdlURL, serviceName);
// You can add whatever address as you want
service.addPort(portName, "http://schemas.xmlsoap.org/soap/",
                 "http://the/new/url/myService");
ServicePort proxy = service.getPort(portName, SEI.class);
```

### Client Cache Control Directives

The following table lists the cache control directives supported by an HTTP client.

<table>
<thead>
<tr>
<th>Directive</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>no-cache</td>
<td>Caches cannot use a particular response to satisfy subsequent requests without first revalidating that response with the server. If specific response header fields are specified with this value, the restriction applies only to those header fields within the response. If no response header fields are specified, the restriction applies to the entire response.</td>
</tr>
<tr>
<td>no-store</td>
<td>Caches must not store any part of a response or any part of the request that invoked it.</td>
</tr>
<tr>
<td>max-age</td>
<td>The consumer can accept a response whose age is no greater than the specified time in seconds.</td>
</tr>
<tr>
<td>max-stale</td>
<td>The consumer can accept a response that has exceeded its expiration time. If a value is assigned to max-stale, it represents the number of seconds beyond the expiration time of a response up to which the consumer can still accept that response. If no value is assigned, it means the consumer can accept a stale response of any age.</td>
</tr>
<tr>
<td>min-fresh</td>
<td>The consumer wants a response that will be still be fresh for at least the specified number of seconds indicated.</td>
</tr>
<tr>
<td>no-transform</td>
<td>Caches must not modify media type or location of the content in a response between a provider and a consumer.</td>
</tr>
</tbody>
</table>
Directive | Behavior
--- | ---
only-if-cached | Caches should return only responses that are currently stored in the cache, and not responses that need to be reloaded or revalidated.
cache-extension | Specifies additional extensions to the other cache directives. Extensions might be informational or behavioral. An extended directive is specified in the context of a standard directive, so that applications not understanding the extended directive can at least adhere to the behavior mandated by the standard directive.

A Note About Chunking

There are two ways of putting a body into an HTTP stream:

- The “standard” way used by most browsers is to specify a Content-Length header in the HTTP headers. This allows the receiver to know how much data is coming and when to stop reading. The problem with this approach is that the length needs to be pre-determined. The data cannot be streamed as generated as the length needs to be calculated upfront. Thus, if chunking is turned off, we need to buffer the data in a byte buffer (or temp file if too large) so that the Content-Length can be calculated.

- Chunked - with this mode, the data is sent to the receiver in chunks. Each chunk is preceded by a hexadecimal chunk size. When a chunk size is 0, the receiver knows all the data has been received. This mode allows better streaming as we just need to buffer a small amount, up to 8K by default, and when the buffer fills, write out the chunk.

In general, Chunked will perform better as the streaming can take place directly. HOWEVER, there are some problems with chunking:

- Many proxy servers don’t understand it, especially older proxy servers. Many proxy servers want the Content-Length up front so they can allocate a buffer to store the request before passing it onto the real server.

- Some of the older WebServices stacks also have problems with Chunking. Specifically, older versions of .NET.

If you are getting strange errors (generally not SOAP faults, but other HTTP type errors) when trying to interact with a service, try turning off chunking to see if that helps.

When to set custom headers

If you use a custom CXF interceptor to set one or more outbound HTTP headers then it is recommended to get this interceptor running at a stage preceding the WRITE stage, before the outbound body is written out.

Otherwise the custom headers may get lost. The headers may get retained in some cases even if they are added after the body is written out, example, when a chunking threshold value (4K by default) has not been reached, but relying on it for the headers not to be lost is brittle and should be avoided.
Asynchronous HTTP Conduit

Please see Asynchronous HTTP Conduit page for more information.

Authentication

Basic Authentication sample:

```xml
<conduit name="{http://example.com/}HelloWorldServicePort.http-conduit"
 xmlns:sec="http://cxf.apache.org/configuration/security"
 xmlns="http://cxf.apache.org/transports/http/configuration">
  <authorization>
    <sec:UserName>myuser</sec:UserName>
    <sec:Password>mypasswd</sec:Password>
    <sec:AuthorizationType>Basic</sec:AuthorizationType>
  </authorization>
</conduit>
```

For Digest Authentication, use the same as above but with AuthorizationType value of Digest.
(Note the AuthorizationType element can be omitted if you’re using Basic authentication, as above.)

Authorization can also be supplied dynamically, by implementing the org.apache.cxf.transport.http.auth.HttpAuthSupplier interface or another interface which extends it. The main method this interface provides is:

```java
public String getAuthorization(AuthorizationPolicy authPolicy,
                               URL currentURL, Message message, String fullHeader);
```

With this method you’ll need to supply the HttpAuthPolicy, the service URL, the CXF message and the full Authorization header (what the server sent in its last response). With the latter value multi-phase authentications can be implemented. For a simple implementation check the org.apache.cxf.transport.http.auth.DefaultBasicAuthSupplier class. On the conduit above, declare your implementation class in an AuthSupplier element for CXF to use it.

Spnego Authentication (Kerberos)

CXF supports Spnego authentication using the standard AuthPolicy mechanism. Spnego is activated by setting the AuthPolicy.authorizationType to 'Negotiate'. If userName is left blank then single sign on is used with the TGT from e.g. Windows Login. If userName is set then a new LoginContext is established and the ticket is created out of this. By default the SpnegoAuthSupplier uses the OID for Spnego. Some servers require the OID for Kerberos. This can be activated by setting the contextual property auth.spnego.useKerberosOid to 'true'.

Kerberos Config: Make sure that krb5.conf/krb5.ini is configured correctly for the Kerberos realm you want to authenticate against and supply it to your application by setting the java.security.krb5.conf system property

Login Config: Create a file login.conf and supply it to CXF using the System property java.security.auth.login.config. The file should contain:
Sample config: Make sure the Authorization element contains the same name as the Section in the login.conf (here: CXFClient).

```xml
<!-- HTTP conduit configuration for spnego with single sign on -->
<conduit name="{http://example.com/}HelloWorldServicePort.http-conduit"
    xmlns="http://cxf.apache.org/transports/http/configuration">
    <authorization>
        <AuthorizationType>Negotiate</AuthorizationType>
        <Authorization>CXFClient</Authorization>
    </authorization>
</conduit>
```

You can use UserName and Password in the above xml config if you want to log in explicitly. If you want to use the cached Ticket Granting Ticket then do not supply them. On Windows you will also have to make sure you allow the TGT to be used in Java. See: http://www.javaactivedirectory.com/?page_id=93 for more information.

```xml
<!-- Switching to Kerberos OID instead of Spnego -->
<jaxws:client>
    <jaxws:properties>
        <entry key="auth.spnego.useKerberosOid" value="true"/>
    </jaxws:properties>
</jaxws:client>
```

### NTLM Authentication

On Java 6, NTLM authentication is built into the Java runtime and you don’t need to do anything special.

Next, you need to configure jcifs to use the correct domains, wins servers, etc... Notice that the bit which sets the username/password to use for NTLM is commented out. If credentials are missing jcifs will use the underlying NT credentials.

```java
//Set the jcifs properties
jcifs.Config.setProperty("jcifs.smb.client.domain", "ben.com");
jcifs.Config.setProperty("jcifs.netbios.wins", "xxx.xxx.xxx.xxx");
jcifs.Config.setProperty("jcifs.smb.client.soTimeout", "300000"); //5 minutes
jcifs.Config.setProperty("jcifs.netbios.cachePolicy", "1200"); //20 minutes
//jcifs.Config.setProperty("jcifs.smb.client.username", "myNTLogin");
//jcifs.Config.setProperty("jcifs.smb.client.password", "secret");
```

Finally, you need to setup the CXF client to turn off chunking. The reason is that the NTLM authentication requires a 3 part handshake which breaks the streaming.

```java
//Turn off chunking so that NTLM can occur
```
Client client = ClientProxy.getClient(port);
HTTPConduit http = (HTTPConduit) client.getConduit();
HTTPClientPolicy httpClientPolicy = new HTTPClientPolicy();
httpClientPolicy.setConnectionTimeout(36000);
httpClientPolicy.setAllowChunking(false);
http.setClient(httpClientPolicy);

Please also see *Asynchronous Client HTTP Transport* for more information on NTLM.

### 2.5.1.2. Server HTTP Transport

HTTP server endpoints can specify a number of HTTP connection attributes including if it will honor keep alive requests, how it interacts with caches, and how tolerant it is of errors in communicating with a consumer.

A server endpoint can be configured using two mechanisms:

- Configuration
- WSDL

**Using Configuration**

**Namespace**

The elements used to configure an HTTP provider endpoint are defined in the namespace http://cxf.apache.org/transports/http/configuration. It is commonly referred to using the prefix `http-conf`. In order to use the HTTP configuration elements you will need to add the lines shown below to the beans element of your endpoint’s configuration file. In addition, you will need to add the configuration elements’ namespace to the `xsi:schemaLocation` attribute.

**Example 2.26. Adding the Configuration Namespace**

```xml
<beans ... 
 ... 
 xsi:schemaLocation="... 
   http://cxf.apache.org/transports/http/configuration 
   http://cxf.apache.org/schemas/configuration/http-conf.xsd 
 ..."/>
```

**The destination element**

You configure an HTTP server endpoint using the `http-conf:destination` element and its children. The `http-conf:destination` element takes a single attribute, `name`, the specifies the
WSDL port element that corresponds to the endpoint. The value for the name attribute takes the form `portQName.http-destination`. The example below shows the `http-conf:destination` element that would be used to add configuration for an endpoint that was specified by the WSDL fragment `<port binding="widgetSOAPBinding" name="widgetSOAPPort">` if the endpoint’s target namespace was `http://widgets.widgetvendor.net`.

**Example 2.27. http-conf:destination Element**

```
<http-conf:destination name="{http://widgets/widgetvendor.net}widgetSOAPPort.http-destination">
  ...
</http-conf:destination>
```

The `http-conf:destination` element has a number of child elements that specify configuration information. They are described below.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>http-conf:server</td>
<td>Specifies the HTTP connection properties.</td>
</tr>
<tr>
<td>http-conf:contextMatchStrategy</td>
<td>Specifies the parameters that configure the context match strategy for processing HTTP requests.</td>
</tr>
<tr>
<td>http-conf:fixedParameterOrder</td>
<td>Specifies whether the parameter order of an HTTP request handled by this destination is fixed.</td>
</tr>
</tbody>
</table>

**The server element**

The `http-conf:server` element is used to configure the properties of a server’s HTTP connection. Its attributes, described below, specify the connection’s properties.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ReceiveTimeout</td>
<td>Sets the length of time, in milliseconds, the server tries to receive a request before the connection times out. The default is 30000. The specify that the server will not timeout use 0.</td>
</tr>
<tr>
<td>SuppressClient-SendErrors</td>
<td>Specifies whether exceptions are to be thrown when an error is encountered on receiving a request. The default is <code>false</code>; exceptions are thrown on encountering errors.</td>
</tr>
<tr>
<td>SuppressClient-ReceiveErrors</td>
<td>Specifies whether exceptions are to be thrown when an error is encountered on sending a response to a client. The default is <code>false</code>; exceptions are thrown on encountering errors.</td>
</tr>
<tr>
<td>HonorKeepAlive</td>
<td>Specifies whether the server honors requests for a connection to remain open after a response has been sent. The default is <code>true</code>; keep-alive requests are honored.</td>
</tr>
<tr>
<td>RedirectURL</td>
<td>Specifies the URL to which the client request should be redirected if the URL specified in the client request is no longer appropriate for the requested resource. In this case, if a status code is not automatically set in the first line of the server response, the status code is set to 302 and the status description is set to Object Moved. The value is used as the value of the HTTP RedirectURL property.</td>
</tr>
<tr>
<td>CacheControl</td>
<td>Specifies directives about the behavior that must be adhered to by caches involved in the chain comprising a response from a server to a client.</td>
</tr>
<tr>
<td>ContentLocation</td>
<td>Sets the URL where the resource being sent in a response is located.</td>
</tr>
</tbody>
</table>
### Attribute Description

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContentType</td>
<td>Specifies the media type of the information being sent in a response. Media types are specified using multipurpose internet mail extensions (MIME) types. The value is used as the value of the HTTP <code>Content-Type</code> location.</td>
</tr>
<tr>
<td>ContentEncoding</td>
<td>Specifies any additional content encodings that have been applied to the information being sent by the service provider. Content encoding labels are regulated by the Internet Assigned Numbers Authority (IANA). Possible content encoding values include zip, gzip, compress, deflate, and identity. This value is used as the value of the HTTP <code>Content-Encoding</code> property.</td>
</tr>
<tr>
<td>ServerType</td>
<td>Specifies what type of server is sending the response. Values take the form <code>program-name/version</code>. For example, Apache/1.2.5.</td>
</tr>
</tbody>
</table>

### Example

The example below shows a the configuration for an HTTP service provider endpoint that honors keep alive requests and suppresses all communication errors.

#### Example 2.28. HTTP Service Provider Endpoint Configuration

```xml
  <http-conf:destination name="{http://apache.org/hello_soap_http}SoapPort.http-destination">
    <http-conf:server SuppressClientSendErrors="true" SuppressClientReceiveErrors="true" HonorKeepAlive="true" />
  </http-conf:destination>
</beans>
```

### Using WSDL

#### Namespace

The WSDL extension elements used to configure an HTTP server endpoint are defined in the namespace `http://cxf.apache.org/transports/http/configuration`. It is commonly referred to using the prefix `http-conf`. In order to use the HTTP configuration elements you will need to add the line shown below to the `definitions` element of your endpoint's WSDL document.

#### Example 2.29. HTTP Provider WSDL Element's Namespace

```xml
<definitions ...
```
The server element

The `http-conf:server` element is used to specify the connection properties of an HTTP server in a WSDL document. The `http-conf:server` element is a child of the WSDL port element. It has the same attributes as the `server` element used in the configuration file.

Example

The example below shows a WSDL fragment that configures an HTTP server endpoint to specify that it will not interact with caches.

Example 2.30. WSDL to Configure an HTTP Service Provider Endpoint

```xml
<service ...>
  <port ...>
    <soap:address ... />
    <http-conf:server CacheControl="no-cache" />
  </port>
</service>
```

Server Cache Control Directives

The table below lists the cache control directives supported by an HTTP server.

<table>
<thead>
<tr>
<th>Directive</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>no-cache</td>
<td>Caches cannot use a particular response to satisfy subsequent requests without first revalidating that response with the server. If specific response header fields are specified with this value, the restriction applies only to those header fields within the response. If no response header fields are specified, the restriction applies to the entire response.</td>
</tr>
<tr>
<td>public</td>
<td>Any cache can store the response.</td>
</tr>
<tr>
<td>private</td>
<td>Public (shared) caches cannot store the response because the response is intended for a single user. If specific response header fields are specified with this value, the restriction applies only to those header fields within the response. If no response header fields are specified, the restriction applies to the entire response.</td>
</tr>
<tr>
<td>no-store</td>
<td>Caches must not store any part of response or any part of the request that invoked it.</td>
</tr>
<tr>
<td>no-transform</td>
<td>Caches must not modify the media type or location of the content in a response between a server and a client.</td>
</tr>
<tr>
<td>must-revalidate</td>
<td>Caches must revalidate expired entries that relate to a response before that entry can be used in a subsequent response.</td>
</tr>
<tr>
<td>proxy-revalidate</td>
<td>Means the same as must-revalidate, except that it can only be enforced on shared caches and is ignored by private unshared caches. If using this directive, the public cache directive must also be used.</td>
</tr>
</tbody>
</table>
### Directive | Behavior
--- | ---
max-age | Clients can accept a response whose age is no greater that the specified number of seconds.
s-max-age | Means the same as max-age, except that it can only be enforced on shared caches and is ignored by private unshared caches. The age specified by s-max-age overrides the age specified by max-age. If using this directive, the proxy-revalidate directive must also be used.
cache-extension | Specifies additional extensions to the other cache directives. Extensions might be informational or behavioral. An extended directive is specified in the context of a standard directive, so that applications not understanding the extended directive can at least adhere to the behavior mandated by the standard directive.

#### 2.5.1.3. Servlet Transport

To create services that use this transport you can either use the CXF APIs (for example, see [JAX-WS](https://jax-ws.dev.java.net/)) or create an XML file which registers services for you.

#### Publishing an endpoint from XML

CXF uses Spring to provide XML configuration of services. This means that first we’ll want to load Spring via a Servlet listener and tell it where our XML configuration file is:

Next, you’ll need to add CXFServlet to your web.xml:

```xml
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE web-app PUBLIC "-//Sun Microsystems, Inc.//DTD Web Application 2.3//EN" "http://java.sun.com/dtd/web-app_2_3.dtd">
<web-app>
  <context-param>
    <param-name>contextConfigLocation</param-name>
    <param-value>classpath:com/acme/ws/services.xml</param-value>
  </context-param>
  <listener>
    <listener-class>org.springframework.web.context.ContextLoaderListener</listener-class>
  </listener>
  <servlet>
    <servlet-name>CXFServlet</servlet-name>
    <display-name>CXF Servlet</display-name>
    <servlet-class>org.apache.cxf.transport.servlet.CXFServlet</servlet-class>
    <load-on-startup>1</load-on-startup>
  </servlet>
</web-app>
```
The next step is to actually write the configuration file:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:jaxws="http://cxf.apache.org/jaxws"
xmlns:jaxrs="http://cxf.apache.org/jaxrs"
xsi:schemaLocation="
http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
http://cxf.apache.org/jaxws
http://cxf.apache.org/schemas/jaxws.xsd
http://cxf.apache.org/jaxrs
http://cxf.apache.org/schemas/jaxrs.xsd">
  <import resource="classpath:META-INF/cxf/cxf.xml"/>
  <import resource="classpath:META-INF/cxf/cxf-extension-soap.xml"/>
  <import resource="classpath:META-INF/cxf/cxf-extension-jaxrs-binding.xml"/>
  <import resource="classpath:META-INF/cxf/cxf-servlet.xml"/>

  <jaxws:endpoint id="greeter"
    implementor="org.apache.hello_soap_http.GreeterImpl"
    address="/Greeter1"/>

  <jaxrs:server id="greeterRest"
    serviceClass="org.apache.hello_soap_http.GreeterImpl"
    address="/GreeterRest"/>
</beans>
```

Here we’re creating a JAX-WS endpoint based on our implementation class, GreeterImpl.

**NOTE:** We’re publishing endpoints "http://localhost/mycontext/services/Greeter1" and "http://localhost/mycontext/services/GreeterRest", but we set jaxws:endpoint/@address and jaxrs:server/@address to relative values such as "/Greeter1" "/GreeterRest".

### Support for Asynchronous Requests

Enable an 'async-supported' servlet property if you work with Servlet3 API containers and need to support asynchronous requests:

```xml
<servlet>
  <servlet-name>CXFServlet</servlet-name>
  <display-name>CXF Servlet</display-name>
  <servlet-class>
    org.apache.cxf.transport.servlet.CXFServlet
  </servlet-class>

  <!-- Enable asynchronous requests -->
  <async-supported>true</async-supported>
</servlet>
```
Redirecting requests and serving the static content

It is possible to configure CXFServlet to redirect current requests to other servlets or serve the static resources.

"redirects-list" init parameter can be used to provide a space separated list of URI patterns; if a given request URI matches one of the patterns then CXFServlet will try to find a RequestDispatcher using the pathInfo of the current HTTP request and will redirect the request to it.

"redirect-servlet-path" can be used to affect a RequestDispatcher lookup, if specified then it will concatenated with the pathInfo of the current request.

"redirect-servlet-name" init parameter can be used to enable a named RequestDispatcher lookup, after one of the URI patterns in the "redirects-list" has matched the current request URI.

"static-resources-list" init parameter can be used to provide a space separated list of static resource such as html, css, or pdf files which CXFServlet will serve directly.

One can have requests redirected to other servlets or JSP pages.

CXFServlets serving both JAXWS and JAXRS based endpoints can avail of this feature.

For example, please see this web.xml.

The http://localhost:9080/the/bookstore1/books/html/123 request URI will initially be matched by the CXFServlet given that it has a more specific URI pattern than the RedirectCXFServlet. After a current URI has reached a jaxrs:server endpoint, the response will be redirected by the JAXRS RequestDispatcherProvider to a "/book.html" address, see "dispatchProvider1" bean here.

Next, the request URI "/book.html" will be handled by RedirectCXFServlet. Note that a uri pattern can be a regular expression. This servlet redirects the request further to a RequestDispatcher capable of handling a "/static/book.html".

Finally, DefaultCXFServlet serves a requested book.html.

Serving welcome pages

Starting from CXF 2.5.5 and 2.6.2 it is possible to configure CXFServlet to serve welcome pages in a number of ways.

For example, lets assume we have a web application called "webapp" which has a root resource called "index.html". For CXFServlet to support both "/webapp" and "/webapp/index.html" requests returning "index.html", while letting all other requests to proceed to the actual endpoints, the following can be done.
Option 1. Delegating to Default Servlet

```xml
<servlet>
  <servlet-name>CXFServlet</servlet-name>
  <display-name>CXF Servlet</display-name>
  <servlet-class>
    org.apache.cxf.transport.servlet.CXFServlet
  </servlet-class>
  <init-param>
    <param-name>redirects-list</param-name>
    <param-value>
      /
      /index.html
    </param-value>
  </init-param>
  <init-param>
    <param-name>redirect-attributes</param-name>
    <param-value>
      javax.servlet.include.request_uri
    </param-value>
  </init-param>
  <init-param>
    <param-name>redirect-servlet-name</param-name>
    <param-value>default</param-value>
  </init-param>
  <load-on-startup>1</load-on-startup>
</servlet>

<servlet-mapping>
  <servlet-name>CXFServlet</servlet-name>
  <url-pattern>/*</url-pattern>
</servlet-mapping>

<welcome-file-list>
  <welcome-file>index.html</welcome-file>
</welcome-file-list>

Note that the redirects-list parameter has two space separated values, "/" and "index.html". The request attribute 'javax.servlet.include.request_uri' might need to be set for the underlying container like Jetty to successfully read "index.html".

Option 2. Using CXFServlet itself to read index.html

```xml
<servlet>
  <servlet-name>CXFServlet</servlet-name>
  <display-name>CXF Servlet</display-name>
  <servlet-class>
    org.apache.cxf.transport.servlet.CXFServlet
  </servlet-class>
  <init-param>
    <param-name>static-welcome-file</param-name>
    <param-value>/index.html</param-value>
  </init-param>
  <init-param>
    <param-name>static-resources-list</param-name>
    <param-value>/index.html</param-value>
  </init-param>
  <load-on-startup>1</load-on-startup>
</servlet>

<servlet-mapping>
  <servlet-name>CXFServlet</servlet-name>
  <url-pattern>*</url-pattern>
</servlet-mapping>

```

```
Publishing an endpoint with the API

Once your Servlet is registered in your web.xml, you should set the default bus with CXFServlet’s bus to make sure that CXF uses it as its HTTP Transport. Simply publish with the related path “Greeter” and your service should appear at the address you specify:

```java
import javax.xml.ws.Endpoint;
import org.apache.cxf.Bus;
import org.apache.cxf.BusFactory;
import org.apache.cxf.transport.servlet.CXFServlet;
.....
// cxf is the instance of the CXFServlet, you could also get
// this instance by extending the CXFServlet
Bus bus = cxf.getBus();
BusFactory.setDefaultBus(bus);
Endpoint.publish("/Greeter", new GreeterImpl());
```

The one thing you must ensure is that your CXFServlet is set up to listen on that path. Otherwise the CXFServlet will never receive the requests.

**NOTE:**

Endpoint.publish(...) is a JAX-WS API for publishing JAX-WS endpoints. Thus, it would require the JAX-WS module and APIs to be present. If you are not using JAX-WS or want more control over the published endpoint properties, you should replace that call with the proper calls to the appropriate ServerFactory.

Since CXFServlet know nothing about the web container listening port and the application context path, you need to specify the relative path instead of the full http address.

Using the servlet transport without Spring

A user who doesn’t want to use the Spring libraries can alternatively publish the endpoint with CXF servlet transport. To do this, extend the CXFNonSpringServlet and then override the method loadBus, e.g.:

```java
@override
public void loadBus(ServletConfig servletConfig)
    throws ServletException {
    super.loadBus(servletConfig);

    // You could add the endpoint publish codes here
    Bus bus = cxf.getBus();
    BusFactory.setDefaultBus(bus);
    Endpoint.publish("/Greeter", new GreeterImpl());

    // You can also use the simple frontend API to do this
```
ServerFactoryBean factory = new ServerFactoryBean();
factory.setBus(bus);
factory.setServiceClass(GreeterImpl.class);
factory setAddress("/Greeter");
factory create();
}

If you are using Jetty as the embedded servlet engine, the endpoint can be published as follows:

// Set up the system properties to use
// the CXFBusFactory not the SpringBusFactory
String busFactory =
    System.getProperty(BusFactory.BUS_FACTORY_PROPERTY_NAME);
System.setProperty(BusFactory.BUS_FACTORY_PROPERTY_NAME,
    "org.apache.cxf.bus.CXFBusFactory");
try {
    // Start up the jetty embedded server
    httpServer = new Server(9000);
    ContextHandlerCollection contexts
        = new ContextHandlerCollection();
    httpServer.setHandler(contexts);

    Context root = new Context(contexts, "/", Context.SESSIONS);

    CXFNonSpringServlet cxf = new CXFNonSpringServlet();
    ServletHolder servlet = new ServletHolder(cxf);
    servlet.setName("soap");
    servlet.setForcedPath("soap");
    root.addServlet(servlet, "/soap/*");
    httpServer.start();

    Bus bus = cxf.getBus();
    setBus(bus);
    BusFactory.setDefaultBus(bus);
    GreeterImpl impl = new GreeterImpl();
    Endpoint.publish("/Greeter", impl);
} catch (Exception e) {
    throw new RuntimeException(e);
} finally {
    // clean up the system properties
    if (busFactory != null) {
        System.setProperty(BusFactory.BUS_FACTORY_PROPERTY_NAME,
            busFactory);
    } else {
        System.clearProperty(BusFactory.BUS_FACTORY_PROPERTY_NAME);
    }
}

Accessing the MessageContext and/or HTTP Request and Response

Sometimes you’ll want to access more specific message details in your service implementation. One example might be accessing the actual request or response object itself. This can be done using the WebServiceContext object.

First, declare a private field for the WebServiceContext in your service implementation, and annotate it as a resource:
@Resource
private WebServiceContext context;

Then, within your implementing methods, you can access the MessageContext, HttpServletRequest, and HttpServletResponse as follows:

```java
import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;
import javax.xml.ws.handler.MessageContext;
...

MessageContext ctx = context.getMessageContext();
HttpServletRequest request = (HttpServletRequest) ctx.get(AbstractHTTPDestination.HTTP_REQUEST);
HttpServletResponse response = (HttpServletResponse) ctx.get(AbstractHTTPDestination.HTTP_RESPONSE);
```

Of course, it is always a good idea to program defensively if using transport-specific entities like the HttpServletRequest and HttpServletResponse. If the transport were changed (for instance to the JMS transport), then these values would likely be null.

### 2.5.1.4. Asynchronous Client HTTP Transport

By default, CXF uses a transport based on the in-JDK HttpURLConnection object to perform HTTP requests. The HttpURLConnection object uses a blocking model for all IO operations which requires a per-thread execution model. From a pure performance standpoint, this model generally performs very well, but it does have problems scaling when many requests need to be executed simultaneously.

Also, the JAX-WS specification allows for generation of asynchronous methods on generated proxies as well as using asynchronous methods on the Dispatch objects. These methods can take an AsyncHandler object and return a polling Future object so applications do not have to wait for the response. With the HttpURLConnection based transport, CXF was forced to consume a background thread for each outstanding request.

CXF also has an HTTP client transport that is based on the Apache HTTP Components HttpAsyncClient library. Its Maven artifactId is cxf-rt-transports-http-hc. The HttpAsyncClient library uses a non-blocking IO model. This allows many more requests to be outstanding without consuming extra background threads. It also allows greater control over things like Keep-Alive handling which is very difficult or impossible with the HttpURLConnection based transport. However, the non-blocking model does not perform quite as well as the blocking model for pure synchronous request/response transactions.

By default, if the cxf-rt-transports-http-hc module is found on the classpath, CXF will use the HttpAsyncClient based implementation for any Async calls, but will continue to use the HttpURLConnection based transport for synchronous calls. This allows a good balance of performance for the common synchronous cases with scalability for the asynchronous cases. However, using a contextual property of "use.async.http.conduit" and set to true/false, you can control whether the async or blocking version is used. If "true", the HttpAsyncClient will be used even for synchronous calls, if "false", asynchronous calls will rely on the traditional method of using HTTPURLConnection along with a work queue to mimic the asynchronicity.
Another reason to use the asynchronous transport is to use HTTP methods that HttpURLConnection does not support. For example, the github.com REST API specifies the use of PATCH for some cases, but HttpURLConnection rejects PATCH.

### Using the HTTP Components Transport from Java Code

To force global use of the HTTP Components transport, you can set a bus-level property:

```java
Bus bus = BusFactory.getDefaultBus();
// insist on the async connector to use PATCH.
bus.setProperty(AsyncHTTPConduit.USE_ASYNC, Boolean.TRUE);
```

### Setting Credentials

The “normal” CXF/JAX-WS method of setting user credentials via the BindingProvider.USERNAME_PROPERTY/PASSWORD_PROPERTY will work with the Async transport as well. However, the HttpAsyncClient library does have some additional capabilities around NTLM that can be leveraged. In order to use that, you need to:

- Turn on the AutoRedirect and turn off the Chunking for the Conduit. This will allow CXF to cache the response in a manner that will allow the transport to keep resending the request during the authentication negotiation.

- Force the use of the Async transport even for synchronous calls

  ```java
  bp.getRequestContext().put("use.async.http.conduit", Boolean.TRUE);
  ```

- Set the property “org.apache.http.auth.Credentials” to an instance of the Credentials. For example:

  ```java
  Credentials creds = new NTCredentials("username", "pswd", null, "domain");
  bp.getRequestContext().put(Credentials.class.getName(), creds);
  ```

### Configuration

The Asynchronous HTTP Transport has several options that can set using Bus properties or via the OSGi configuration services to control various aspects of the underlying Apache HTTP Components HttpAsyncClient objects.

Settings related to the underlying TCP socket (see the java.net.Socket JavaDoc for a definition of these values):

<table>
<thead>
<tr>
<th>Option</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>org.apache.cxf.transport.http.async.TCP_NODELAY</td>
<td>true</td>
</tr>
<tr>
<td>org.apache.cxf.transport.http.async.SO_KEEPALIVE</td>
<td></td>
</tr>
<tr>
<td>org.apache.cxf.transport.http.async.SO_LINGER</td>
<td></td>
</tr>
</tbody>
</table>
Option

org.apache.cxf.transport.http.async.SO_TIMEOUT

Settings related to Keep-Alive connection management:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>org.apache.cxf.transport.http.async.CONNECTION_TTL</td>
<td>Maximum time a connection is held open in ms. Default is 60000.</td>
</tr>
<tr>
<td>org.apache.cxf.transport.http.async.MAX_CONNECTIONS</td>
<td>Maximum number of connections opened per host. Default is 1000.</td>
</tr>
<tr>
<td>org.apache.cxf.transport.http.async.MAX_PER_HOST_CONNECTIONS</td>
<td>Maximum number of connections opened in total. Default is 5000.</td>
</tr>
</tbody>
</table>

Settings related to Apache HttpAsyncClient threads and selectors:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>org.apache.cxf.transport.http.async.ioThreadCount</td>
<td>Number of threads HttpAsyncClient uses to process IO events. Default is &quot;-1&quot; which means one thread per CPU core.</td>
</tr>
<tr>
<td>org.apache.cxf.transport.http.async.interestOpQueued</td>
<td>true/false for whether the interest ops are queues or process directly.</td>
</tr>
<tr>
<td>org.apache.cxf.transport.http.async.selectInterval</td>
<td>Default 1000 ms. How often the selector thread wakes up if there are no events to process additional things like queue expirations.</td>
</tr>
</tbody>
</table>

Settings to control which conduit is used:

<table>
<thead>
<tr>
<th>Option</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>org.apache.cxf.transport.http.async.usePolicy</td>
<td>ALWAYS, ASYNC_ONLY, NEVER</td>
<td>Similar in meaning to the “use.async.http.conduit” context property described above. Whether to use the HttpAsyncClient: ALWAYS for both synchronous and asynchronous calls, ASYNC_ONLY (default) for asynchronous calls only, NEVER will use HTTPURLConnection for both types of calls.</td>
</tr>
</tbody>
</table>

2.5.2. JMS Transport

CXF provides a transport plug-in that enables endpoints to use Java Message Service (JMS) queues and topics. CXF’s JMS transport plug-in uses the Java Naming and Directory Interface (JNDI) to locate and obtain references to the JMS provider that brokers for the JMS destinations. Once CXF has established a connection to a JMS provider, CXF supports the passing of messages packaged as either a JMS ObjectMessage or a JMS TextMessage. The JMS transport also supports the SOAP over JMS specification, see SOAP over JMS 1.0 support.

Standard JMS transport configuration in CXF is done by defining a JMSConduit or JMSDestination, discussed below. There is however an alternative configuration option more conformant to Spring dependency injection, see Using the JMSConfigFeature.
2.5.2.1. JMS Namespaces

WSDL Namespace

The WSDL extensions for defining a JMS endpoint are defined in the namespace http://cxf.apache.org/transports/jms. In order to use the JMS extensions you will need to add the namespace definition shown below to the definitions element of your contract.

Example 2.31. JMS Extension Namespace

```xml
xmlns:jms="http://cxf.apache.org/transports/jms"
```

Configuration Namespaces

In order to use the JMS configuration properties you will need to add the line shown below to the beans element of your configuration.

Example 2.32. JMS Configuration Namespaces

```xml
xmlns:jms="http://cxf.apache.org/transports/jms"
```

2.5.2.2. Basic Endpoint Configuration

JMS endpoints need to know certain basic information about how to establish a connection to the proper destination. This information can be provided in one of two places: WSDL or XML configuration. The following configuration elements which are described can be used in both the client side Conduits and the server side Destinations.

Using WSDL

The JMS destination information is provided using the jms:address element and its child, the jms:JMSNamingProperties element. The jms:address element’s attributes specify the information needed to identify the JMS broker and the destination. The jms:JMSNamingProperties element specifies the Java properties used to connect to the JNDI service.

The address element

The basic configuration for a JMS endpoint is done by using a jms:address element as the child of your service’s port element. The jms:address element uses the attributes described below to configure the connection to the JMS broker.
Attribute | Description
--- | ---
destinationStyle | Specifies if the JMS destination is a JMS queue or a JMS topic.
nndiConnectionFactoryName | Specifies the JNDI name bound to the JMS connection factory to use when connecting to the JMS destination.
nndiDestinationName | Specifies the JNDI name bound to the JMS destination to which requests are sent.
nndiReplyDestinationName | Specifies the JNDI name bound to the JMS destinations where replies are sent. This attribute allows you to use a user defined destination for replies.
connectionUserName | Specifies the username to use when connecting to a JMS broker.
connectionPassword | Specifies the password to use when connecting to a JMS broker.

The JMSNamingProperties element

To increase interoperability with JMS and JNDI providers, the `jms:address` element has a child element, `jms:JMSNamingProperties`, that allows you to specify the values used to populate the properties used when connecting to the JNDI provider. The `jms:JMSNamingProperties` element has two attributes: `name` and `value`. The `name` attribute specifies the name of the property to set. The `value` attribute specifies the value for the specified property. The `jms:JMSNamingProperties` element can also be used for specification of provider specific properties. The following is a list of common JNDI properties that can be set:

- `java.naming.factory.initial`
- `java.naming.provider.url`
- `java.naming.factory.object`
- `java.naming.factory.state`
- `java.naming.factory.url.pkgs`
- `java.naming.dns.url`
- `java.naming.authoritative`
- `java.naming.batchsize`
- `java.naming.referral`
- `java.naming.security.protocol`
- `java.naming.security.authentication`
- `java.naming.security.principal`
- `java.naming.security.credentials`
• java.naming.language

• java.naming.applet

For more details on what information to use in these attributes, check your JNDI provider’s documentation and consult the Java API reference material.

**Using a named reply destination**

By default, CXF endpoints using JMS create a temporary queue for sending replies back and forth. You can change this behavior by setting the `jndiReplyDestinationName` attribute in the endpoint’s contract. A client endpoint will listen for replies on the specified destination and it will specify the value of the attribute in the `ReplyTo` field of all outgoing requests. A service endpoint will use the value of the `jndiReplyDestinationName` attribute as the location for placing replies if there is no destination specified in the request’s `ReplyTo` field.

A static reply queue can not be shared by several instances of the service client. Please use a dynamic reply queue or different queue names per instance instead.

The following example shows an example of a JMS WSDL port specification.

**Example 2.33. JMS WSDL Port Specification**

```xml
<service name="JMSService">
  <port binding="tns:Greeter_SOAPBinding" name="SoapPort">
    <jms:address jndiConnectionFactoryName="ConnectionFactory"
                  jndiDestinationName="dynamicQueues/test.cxf.jmstransport">
      <jms:JMSNamingProperty name="java.naming.factory.initial" value="org.apache.activemq.jndi.ActiveMQInitialContextFactory"/>
      <jms:JMSNamingProperty name="java.naming.provider.url" value="tcp://localhost:61616"/>
    </jms:address>
  </port>
</service>
```

**Using Configuration**

In addition to using the WSDL file to specify the connection information for a JMS endpoint, you can also supply it in the endpoint’s XML configuration. The information in the configuration file will override the information in the endpoint’s WSDL file.

**Configuration elements**

You configure a JMS endpoint using one of the following configuration elements:

- **.jms:conduit**: The `jms:conduit` element contains the configuration for a consumer endpoint. It has one attribute, `name`, whose value takes the form

```xml
{WSDLNamespace}WSDLPortName.jms-conduit
```
• **jms:destination**: The `jms:destination` element contains the configuration for a provider endpoint. It has one attribute, `name`, whose value takes the form

```
{WSDLNamespace}WSDLPortName.jms-destination
```

**The address element**

JMS connection information is specified by adding a `jms:address` child to the base configuration element. The `jms:address` element used in the configuration file is identical to the one used in the WSDL file. Its attributes are listed in the `address element's attribute table` [92]. Like the `jms:address` element in the WSDL file, the `jms:address` configuration element also has a `jms:JMSNamingProperties` child element that is used to specify additional information used to connect to a JNDI provider.

**Example 2.34. Addressing Information in a Configuration File**

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:ct="http://cxf.apache.org/configuration/types"
       xmlns:jms="http://cxf.apache.org/transports/jms"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
                          http://www.springframework.org/schema/beans/spring-beans.xsd
                          http://cxf.apache.org/jaxws
                          http://cxf.apache.org/schemas/jaxws.xsd
                          http://cxf.apache.org/transports/jms
                          http://cxf.apache.org/schemas/configuration/jms.xsd">
  <jms:conduit name="{http://cxf.apache.org/jms_endpt}HelloJMSPort.jms-conduit">
    <jms:address destinationStyle="queue"
                 jndiConnectionFactoryName="myConnectionFactory"
                 jndiDestinationName="myDestination"
                 jndiReplyDestinationName="myReplyDestination"
                 connectionUserName="testUser"
                 connectionPassword="testPassword">
      <jms:JMSNamingProperty name="java.naming.factory.initial" value="org.apache.cxf.transport.jms.MyInitialContextFactory"/>
      <jms:JMSNamingProperty name="java.naming.provider.url" value="tcp://localhost:61616"/>
    </jms:address>
  </jms:conduit>
</beans>
```

**Consumer Endpoint Configuration**

JMS consumer endpoints specify the type of messages they use. JMS consumer endpoint can use either a JMS `ObjectMessage` or a JMS `TextMessage`. When using an `ObjectMessage` the consumer endpoint uses a `byte[]` as the method for storing data into and retrieving data from the JMS message body. When messages are sent, the message data, including any formatting information, is packaged into a `byte[]` and placed into the JMS message body before it is placed on the wire.
When messages are received, the consumer endpoint will attempt to unmarshall the data stored in the JMS body as if it were packed in a `byte[]`.

When using a `TextMessage`, the consumer endpoint uses a string as the method for storing and retrieving data from the JMS message body. When messages are sent, the message information, including any format-specific information, is converted into a string and placed into the JMS message body. When messages are received the consumer endpoint will attempt to unmarshall the data stored in the JMS message body as if it were packed into a string.

When native JMS applications interact with CXF consumers, the JMS application is responsible for interpreting the message and the formatting information. For example, if the CXF contract specifies that the binding used for a JMS endpoint is SOAP, and the messages are packaged as `TextMessage`, the receiving JMS application will get a text message containing all of the SOAP envelope information.

Consumer endpoint can be configured by both XML configuration and via WSDL.

**Using Configuration**

**Specifying the message type**

You can specify the message type supported by the consumer endpoint using a `jms:runtimePolicy` element that has a single attribute:

- `messageType` - Specifies how the message data will be packaged as a JMS message. `text` specifies that the data will be packaged as a `TextMessage`. `binary` specifies that the data will be packaged as an `ObjectMessage`.

The following example shows a configuration entry for configuring a JMS consumer endpoint.

**Example 2.35. Configuration for a JMS Consumer Endpoint**

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:ct="http://cxf.apache.org/configuration/types"
 xmlns:jms="http://cxf.apache.org/transports/jms"
 xsi:schemaLocation="http://www.springframework.org/schema/beans
 http://www.springframework.org/schema/beans/spring-beans.xsd"
 http://cxf.apache.org/jaxws
 http://cxf.apache.org/schemas/jaxws.xsd
 http://cxf.apache.org/transports/jms
 http://cxf.apache.org/schemas/configuration/jms.xsd">
   ...
   <jms:conduit
     name="{http://cxf.apache.org/jms_endpt}HelloJMSPort.jms-conduit">
     <jms:runtimePolicy messageType="binary"/>
     ...
   </jms:conduit>
   ...
</beans>
```
The id on the `jms:conduit` is in the form of `{WSDLNamespace}WSDLPortName.jms-conduit`. This provides CXF with the information so that it can associate the configuration with your service’s endpoint.

**Using WSDL**

The type of messages accepted by a JMS consumer endpoint is configured using the optional `jms:client` element. The `jms:client` element is a child of the WSDL port element and has one attribute:

- **messageType** - Specifies how the message data will be packaged as a JMS message. `text` specifies that the data will be packaged as a `TextMessage`. `binary` specifies that the data will be packaged as an `ObjectMessage`.

**2.5.2.3. Service Endpoint Configuration**

JMS service endpoints have a number of behaviors that are configurable in the contract. These include:

- how messages are correlated
- the use of durable subscriptions
- if the service uses local JMS transactions
- the message selectors used by the endpoint

Service endpoints can be configure in one of two ways:

- Configuration
- WSDL

**Using Configuration**

**Specifying configuration data**

Using the `jms:destination` elements you can configure your service’s endpoint. You can specify the service endpoint’s behaviors using the `jms:runtimePolicy` element that has a the following attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>useMessageIDAsCorrelationID</td>
<td>Specifies whether the JMS broker will use the message ID to correlate messages. The default is <code>false</code>.</td>
</tr>
<tr>
<td>Attribute</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>durableSubscriberName</td>
<td>Specifies the name used to register a durable subscription.</td>
</tr>
<tr>
<td>messageSelector</td>
<td>Specifies the string value of a message selector to use. For more information on the syntax used to specify message selectors, see the JMS 1.1 specification.</td>
</tr>
<tr>
<td>transactional</td>
<td>Specifies whether the local JMS broker will create transactions around message processing. The default is false.</td>
</tr>
</tbody>
</table>

The following example shows a CXF configuration entry for configuring a JMS service endpoint.

**Example 2.36. Configuration for a JMS Service Endpoint**

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ct="http://cxf.apache.org/configuration/types"
xmlns:jms="http://cxf.apache.org/transports/jms"
xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans.xsd"
http://cxf.apache.org/jaxws
http://cxf.apache.org/schemas/jaxws.xsd
http://cxf.apache.org/transports/jms
http://cxf.apache.org/schemas/configuration/jms.xsd">
...
  <jms:destination name="{http://cxf.apache.org/jms_endpt}HelloJMSPort.jms-destination">
    <jms:address ... />
    ...
  </jms:destination>
...
</beans>
```

**Using WSDL**

Service endpoint behaviors are configured using the optional `jms:server` element. The `jms:server` element is a child of the WSDL `port` element and has the following attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>useMessageIDAsCorrelationID</td>
<td>Specifies whether JMS will use the message ID to correlate messages. The default is false.</td>
</tr>
<tr>
<td>durableSubscriberName</td>
<td>Specifies the name used to register a durable subscription.</td>
</tr>
<tr>
<td>messageSelector</td>
<td>Specifies the string value of a message selector to use. For more information on the syntax used to specify message selectors, see the JMS 1.1 specification.</td>
</tr>
<tr>
<td>Attribute</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>transactional</td>
<td>Specifies whether the local JMS broker will create transactions around message processing. The default is false. Currently, this is not supported by the runtime.</td>
</tr>
</tbody>
</table>

### 2.5.2.4. JMS Runtime Configuration

In addition to configuring the externally visible aspects of your JMS endpoint, you can also configure aspects of its internal runtime behavior. There are three types of runtime configuration:

- Session pool configuration (common to both services and consumers)
- Consumer specific configuration
- Service specific configuration

#### Session Pool Configuration

You configure an endpoint’s JMS session pool using the `jms:sessionPoolConfig` element. This property allows you to set a high and low water mark for the number of JMS sessions an endpoint will keep pooled. The endpoint is guaranteed to maintain a pool of sessions equal to the low water mark and to never pool more sessions than specified by the high water mark. The `jms:sessionPool` element’s attributes, listed below, specify the high and low water marks for the endpoint’s JMS session pool.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lowWaterMark</td>
<td>Specifies the minimum number of JMS sessions pooled by the endpoint. The default is 20.</td>
</tr>
<tr>
<td>highWaterMark</td>
<td>Specifies the maximum number of JMS sessions pooled by the endpoint. The default is 500.</td>
</tr>
</tbody>
</table>

The following example shows an example of configuring the session pool for a CXF JMS service endpoint.

**Example 2.37. JMS Session Pool Configuration**

```xml
<jms:destination name="{http://cxf.apache.org/jms_endpit}HelloJMSPort.jms-destination">
  ...
  <jms:sessionPool lowWaterMark="10" highWaterMark="5000" />
</jms:destination>
```

The `jms:sessionPool` element can also be used within a `jms:conduit`.

#### Consumer Specific Runtime Configuration

The JMS consumer configuration allows you to specify two runtime behaviors:
• the number of milliseconds the consumer will wait for a response.

• the number of milliseconds a request will exist before the JMS broker can remove it.

You use the `jms:clientConfig` element to set JMS consumer runtime behavior. This element’s attributes, listed in the following table, specify the configuration values for consumer runtime behavior.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>clientReceiveTimeout</td>
<td>Specifies the amount of time, in milliseconds, that the endpoint will wait for a response before it times out and issues an exception. The default value is 2000.</td>
</tr>
<tr>
<td>messageTimeToLive</td>
<td>Specifies the amount of time, in milliseconds, that a request can remain unreceived before the JMS broker can delete it. The default value is 0 which specifies that the message can never be deleted.</td>
</tr>
</tbody>
</table>

The following example shows a configuration fragment that sets the consumer endpoint’s request lifetime to 500 milliseconds and its timeout value to 500 milliseconds.

**Example 2.38. JMS Consumer Endpoint Runtime Configuration**

```xml
<jms:conduit name="{http://cxf.apache.org/jms_endpt}HelloJMSPort.jms-conduit">
    ...  
    <jms:clientConfig clientReceiveTimeout="500"
                      messageTimeToLive="500" />
</jms:conduit>
```

**Service Specific Runtime Configuration**

The JMS service configuration allows you to specify to runtime behaviors:

• the amount of time a response message can remain unreceived before the JMS broker can delete it.

• the client identifier used when creating and accessing durable subscriptions.

The `jms:serverConfig` element is used to specify the service runtime configuration. This element’s attributes, listed below, specify the configuration values that control the service’s runtime behavior.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>messageTimeToLive</td>
<td>Specifies the amount of time, in milliseconds, that a response can remain unread before the JMS broker is allowed to delete it. The default is 0 which specifies that the message can live forever.</td>
</tr>
<tr>
<td>durableSubscriptionClientId</td>
<td>Specifies the client identifier the endpoint uses to create and access durable subscriptions.</td>
</tr>
</tbody>
</table>

The following example shows a configuration fragment that sets the service endpoint’s response lifetime to 500 milliseconds and its durable subscription client identifier to `jms-test-id`. 
Example 2.39. JMS Service Endpoint Runtime Configuration

```xml
<jms:destination
    id="{http://cxf.apache.org/jms_endpt}HelloJMSPort.jms-destination">
    <jms:address ... />
    ...
    <jms:serverConfig messageTimeToLive="500"
        durableSubscriptionClientId="jms-test-id"/>
</jms:destination>
```

2.5.2.5. SOAP over JMS 1.0 support

The JMS Transport offers an alternative messaging mechanism to SOAP over HTTP. SOAP over JMS offers more reliable and scalable messaging support than SOAP over HTTP. The SOAP over JMS specification is aimed at a set of standards for the transport of SOAP messages over JMS. Its main purpose is to ensure interoperability between the implementations of different Web services vendors. CXF supports and is compliant with this specification.

SOAP over JMS Namespace

JMS URI

JMS endpoints need to know the address information for establishing connections to the proper destination. SOAP over JMS implements the URI Scheme for Java Message Service 1.0.

<table>
<thead>
<tr>
<th>JMS URI Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>jms:&lt;variant&gt;;&lt;destination name&gt;?param1=value1&amp;param2=value2</td>
</tr>
</tbody>
</table>

Variants

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>jndi</td>
<td>Destination name is a jndi queue name</td>
</tr>
<tr>
<td>jndi-topic</td>
<td>Destination name is a jndi topic name</td>
</tr>
<tr>
<td>queue</td>
<td>Destination is a queue name resolved using JMS</td>
</tr>
<tr>
<td>topic</td>
<td>Destination is a topic name resolved using JMS</td>
</tr>
</tbody>
</table>

Further parameters can be added as query parameters in the URI.

For example:

```xml
jms:jndi:SomeJndiNameForDestination?jndiInitialContextFactory= //
org.apache.activemq.jndi.ActiveMQInitialContextFactory&   //
```
**JAX-WS Development**

```plaintext
jndiURL=tcp://localhost:61616&priority=3&
jms:queue:ExampleQueueName?timeToLive=1000
```

## JMS parameters

<table>
<thead>
<tr>
<th>Query Parameter</th>
<th>From Version</th>
<th>DefaultValue</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>conduitIdSelectorPrefix</td>
<td>3.0.0</td>
<td></td>
<td>If set then this string will be the prefix for all correlation ids the conduit creates and also be used in the selector for listening to replies.</td>
</tr>
<tr>
<td>deliveryMode</td>
<td>PERSISTENT</td>
<td></td>
<td>NON_PERSISTENT messages will keep only in memory.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PERSISTENT messages will be saved to disk.</td>
</tr>
<tr>
<td>durableSubscriptionClientId</td>
<td>3.0.1</td>
<td></td>
<td>Optional Client identifier for the connection. The purpose is to associate a connection with a state maintained on behalf of the client by a provider. The only such state identified by the JMS API is that required to support durable subscriptions.</td>
</tr>
<tr>
<td>durableSubscriptionName</td>
<td>3.0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>jndiConnectionFactoryName</td>
<td></td>
<td>ConnectionFactory</td>
<td>Specifies the JNDI name bound to the JMS connection factory to use when connecting to the JMS destination.</td>
</tr>
<tr>
<td>jndiInitialContextFactory</td>
<td></td>
<td></td>
<td>Specifies the fully qualified Java class name of the &quot;InitialContextFactory&quot; implementation class to use.</td>
</tr>
<tr>
<td>jndiTransactionManagerName</td>
<td>3.0.0</td>
<td></td>
<td>Name of the JTA TransactionManager. Will be searched in spring, blueprint and jndi.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If a transaction manager is found then JTA transactions will be enabled. See details below.</td>
</tr>
<tr>
<td>jndiURL</td>
<td></td>
<td></td>
<td>Specifies the JNDI provider URL.</td>
</tr>
<tr>
<td>jndi-*</td>
<td></td>
<td></td>
<td>Additional parameters for a JNDI provider</td>
</tr>
<tr>
<td>messageType</td>
<td>3.0.0</td>
<td>byte</td>
<td>JMS message type used by CXF (byte, text or binary)</td>
</tr>
<tr>
<td>password</td>
<td>3.0.0</td>
<td></td>
<td>Password for creating the connection. Using this in the URI is discouraged</td>
</tr>
<tr>
<td>priority</td>
<td>3.0.0</td>
<td>4</td>
<td>Priority for the messages. See your JMS provider documentation for details. Values range from 0 to 9 where 0 is lowest priority</td>
</tr>
<tr>
<td>replyToName</td>
<td></td>
<td></td>
<td>Specifies the JNDI name bound to the JMS destinations where replies are sent.</td>
</tr>
<tr>
<td>receiveTimeout</td>
<td>3.0.0</td>
<td>60000</td>
<td>Timeout in milliseconds the client waits for a reply in case of request / reply exchanges.</td>
</tr>
<tr>
<td>reconnectOnException</td>
<td>deprecated in 3.0.0</td>
<td>true</td>
<td>Should the transport reconnect in case of exceptions. From version 3.0.0 on the transport will always reconnect in case of exceptions.</td>
</tr>
<tr>
<td>sessionTransacted</td>
<td>3.0.0</td>
<td>false</td>
<td>Set to true for resource local transactions. Do not set if you use JTA</td>
</tr>
</tbody>
</table>
### WSDL Extension

The WSDL extensions for defining a JMS endpoint use a special namespace. In order to use the JMS WSDL extensions you will need to add the namespace definition shown below to the definitions element of your contract.

```xml
xmlns:soapjms="http://www.w3.org/2010/soapjms/
```

Various JMS properties may be set in three places in the WSDL — the binding, the service, and the port. Values specified at the service will propagate to all ports. Values specified at the binding will propagate to all ports using that binding. For example, if the `jndiInitialContextFactory` is indicated for a service, it will be used for all of the port elements it contains.

### JMS Properties

For details refer to the URI query parameters with the same name:

<table>
<thead>
<tr>
<th>Name</th>
<th>Version</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>deliveryMode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>jndiConnectionFactoryName</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>jndiInitialContextFactory</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>jndiURL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>replyToName</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>priority</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>timeToLive</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here is an example:

**Example 2.40. Ways to define a Service with JMS transport**

```xml
<wsdl11:binding name="exampleBinding">
  <soapjms:jndiContextParameter name="name" value="value"/>
  <soapjms:jndiConnectionFactory>
    ConnectionFactory
  </soapjms:jndiConnectionFactory>
  <soapjms:jndiInitialContextFactory>
    org.apache.activemq.jndi.ActiveMQInitialContextFactory
  </soapjms:jndiInitialContextFactory>
  <soapjms:jndiURL>tcp://localhost:61616</soapjms:jndiURL>
```
If a property is specified at multiple levels, the setting at the most granular level takes precedence (port first, then service, then binding). In the above example, notice the timeToLive property — for the quickPort port, the value will be 10ms (specified at the port level). For the slowPort port, the value will be 100ms (specified at the service level). In this example, the setting in the binding will always be overridden.

**WSDL Usage**

For this example:

**Example 2.41. Greeter Service with JMS transaport**

```xml
<wSDL:definitions name="JMSGreeterService"
   xmlns:soap="http://schemas.xmlsoap.org/wsd1/soap/
   xmlns:tns="http://cxf.apache.org/jms_greeter"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
   xmlns:wSDL="http://schemas.xmlsoap.org/wsd1/
   xmlns:xmls="http://cxf.apache.org/jms_greeter/types"
xmlns:soapjms="http://www.w3.org/2010/soapjms/"
   name="JMSGreeterService" targetNamespace="http://cxf.apache.org/jms_greeter">
  ...
  <wSDL:binding name="JMSGreeterPortBinding"
    type="tns:JMSGreeterPortType">
    <soap:binding style="document"
      transport="http://www.w3.org/2010/soapjms/" />
    <soapjms:jndiContextParameter name="name"
      value="value" />
    <soapjms:jndiConnectionFactoryName>
      ConnectionFactory
    </soapjms:jndiConnectionFactoryName>
    <soapjms:jndiInitialContextFactory>
      org.apache.activemq.jndi.ActiveMQInitialContextFactory
    </soapjms:jndiInitialContextFactory>
    <soapjms:jndiURL>tcp://localhost:61616</soapjms:jndiURL>
    <soapjms:deliveryMode>PERSISTENT</soapjms:deliveryMode>
    <soapjms:priority>5</soapjms:priority>
    <soapjms:timeToLive>1000</soapjms:timeToLive>
    <wSDL:operation name="greetMe">
      <soap:operation soapAction="test" style="document" />
```
• The transport URI (http://www.w3.org/2010/soapjms/) is defined in the <soap:binding>.
• The jms: URI is defined in the <soap:address>
• The extension properties are in the <soap:binding>

Define service endpoint or proxy in spring or blueprint

The JAXWS endpoint or proxy can be defined like in the SOAP/HTTP case. Just use a jms: uri like described above.

In CXF 3 it is possible to omit the jndi settings. Just specify an endpoint like this:

**Example 2.42. Endpoint in spring**

```xml
<bean id="ConnectionFactory" class="org.apache.activemq.ActiveMQConnectionFactory">
    <property name="brokerURL" value="tcp://localhost:61616"/>
</bean>
</jaxws:endpoint>
```

or a Client like this:

**Example 2.43. Proxy in spring**

```xml
<bean id="ConnectionFactory" class="org.apache.activemq.ActiveMQConnectionFactory">
    <property name="brokerURL" value="tcp://localhost:61616"/>
</bean>
</jaxws:client>
```
The connection factory will be looked up as a bean in the context. By default the name "ConnectionFactory" is assumed but it can be configured using the jndiConnectionFactoryName uri parameter.

Alternatively the connection factory can be set using the ConnectionFactoryFeature.

---

**Publishing a service with the JAVA API**

Developers who don't wish to modify the WSDL file can also publish the endpoint information using Java code. For CXF's SOAP over JMS implementation you can write the following:

```java
// You just need to set the address with JMS URI
String address = "jms:jndi:dynamicQueues/test.cxf.jmstransport.queue3"
   + "?jndiInitialContextFactory=
   + "org.apache.activemq.jndi.ActiveMQInitialContextFactory"
   + "&jndiConnectionFactoryName=ConnectionFactory&jndiURL"
   + "=tcp://localhost:61500";
Hello implementor = new HelloImpl();
JaxWsServerFactoryBean svrFactory = new JaxWsServerFactoryBean();
svrFactory.setServiceClass(Hello.class);
svrFactory.setAddress(address);
// And specify the transport ID with SOAP over JMS specification
svrFactory.setTransportId(JMSSpecConstants.SOAP_JMS_SPECIFICIATION_TRANSPORTID);
svrFactory.setServiceBean(implementor);
svrFactory.create();
```

**NOTE:** For tests it can be useful to create an embedded broker like this:

```java
public final void run() {
    try {
        broker = new BrokerService();
        broker.setPersistent(false);
        broker.setPersistenceAdapter(new MemoryPersistenceAdapter());
        broker.setTmpDataDirectory(new File("./target"));
        broker.setUseJmx(false);
        if (brokerName != null) {
            broker.setBrokerName(brokerName);
        }
        broker.addConnector(brokerUrl1);
        broker.start();
    } catch (Exception e) {
        e.printStackTrace();
    }
}
```

---

**Consume the service with the API**

Sample code to consume a SOAP-over-JMS service is as follows:

```java
public void invoke() throws Exception {
    // You just need to set the address with JMS URI
    String address = "jms:jndi:dynamicQueues/test.cxf.jmstransport.queue3"
        + "?jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory"
        + "&jndiConnectionFactoryName=ConnectionFactory"
```
+ "&jndiURL=tcp://localhost:61500";
JaxWsProxyFactoryBean factory = new JaxWsProxyFactoryBean();
// And specify the transport ID with SOAP over JMS specification
factory.setTransportId(
    JMSSpecConstants.SOAP_JMS_SPECIFICATION_TRANSPORTID);
factory.setServiceClass(Hello.class);
factory.setAddress(address);
Hello client = (Hello)factory.create();
String reply = client.sayHi(" HI");
System.out.println(reply);
}

// Alternatively using the JAXWS API with jms details defined in WSDL while
avoiding JNDI
SOAPService2 service = new SOAPService2(wsdl, serviceName); // Using the
generated service
ConnectionFactory cf = new ActiveMQConnectionFactory("tcp://localhost:61500");
ConnectionFactoryFeature cff = new ConnectionFactoryFeature(cf);
Greeter greeter = service.getPort(portName, Greeter.class, cff);
// Connection Factory can be set as a feature in CXF >= 3.0.0
svrFactory.setAddress("jms:queue:test.cxf.jmstransport.queue?timeToLive=1000");
// For CXF >= 3.0.0
svrFactory.setFeatures(Collections.singletonList(new
    ConnectionFactoryFeature(cf)));

In this case case the connection factory is supplied using a feature. For CXF 2.x the connection
factory can only be supplied using jndi.

### 2.5.2.6. Using the JMSConfigFeature

Standard JMS transport configuration in CXF is done by defining a JMSConduit or JMSDestination.
There is however an easier configuration option more conformant to Spring dependency injection.
Additionally the new configuration offers many more options. For example it is not necessary
anymore to use JNDI to resolve the connection factory. Instead it can be defined in the Spring
configuration.

The following example configs use the p-namespace from Spring 2.5 but the old Spring bean
style is also possible.

Inside a features element the JMSConfigFeature can be defined.

```
<jaxws:client id="CustomerService"
    xmlns:customer="http://customerservice.example.com/"
    serviceName="customer:CustomerServiceService"
    endpointName="customer:CustomerServiceEndpoint" address="jms:///
    serviceClass="com.example.customerservice.CustomerService">
    <jaxws:features>
        <bean xmlns="http://www.springframework.org/schema/beans"
            class="org.apache.cxf.transport.jms.JMSConfigFeature"
            p:jmsConfig-ref="jmsConfig"/>
    </jaxws:features>
</jaxws:client>
```

In the above example it references a bean “jmsConfig” where the whole configuration for the JMS
transport can be done.
A jaxws Endpoint can be defined in the same way:

```xml
<jaxws:endpoint
    xmlns:customer="http://customerservice.example.com/
    id="CustomerService"
    address="jms://"
    serviceName="customer:CustomerServiceService"
    endpointName="customer:CustomerServiceEndpoint"
    implementor="com.example.customerservice.impl.CustomerServiceImpl">
    <jaxws:features>
        <bean class="org.apache.cxf.transport.jms.JMSConfigFeature"
            p:jmsConfig-ref="jmsConfig" />
    </jaxws:features>
</jaxws:endpoint>
```

The JMSConfiguration bean needs at least a reference to a connection factory and a target destination.

```xml
<bean id="jmsConfig" class="org.apache.cxf.transport.jms.JMSConfiguration"
    p:connectionFactory-ref="jmsConnectionFactory"
    p:targetDestination="test.cxf.jmstransport.queue" />
```

If your ConnectionFactory does not cache connections you should wrap it in a Spring SingleConnectionFactory. This is necessary because the JMS Transport creates a new connection for each message and the SingleConnectionFactory is needed to cache this connection.

```xml
<bean id="jmsConnectionFactory"
    class="org.springframework.jms.connection.SingleConnectionFactory">
    <property name="targetConnectionFactory">
        <bean class="org.apache.activemq.ActiveMQConnectionFactory">
            <property name="brokerURL" value="tcp://localhost:61616"/>
        </bean>
    </property>
</bean>
```

### Using JMSConfiguration from Java

To do this from Java, you need to initialize a JMSConfiguration object, then store a reference to it in a JMSConfigFeature, and then add that to the features in the server factory. The code that follows is fragmentary. Note that you can’t use query parameters in the endpoint URI that you set in the server factory, all the configuration has to be in the JMSConfiguration object.

```java
public static JMSConfiguration newJMSConfiguration(String taskId, String jmsBrokerUrl) {
    String destinationUri = "jms:queue:" + taskId;
    JMSConfiguration conf = new JMSConfiguration();
    conf.setRequestURI(destinationUri);
    JNDIConfiguration jndiConfig = new JNDIConfiguration();
    JndiTemplate jt = new JndiTemplate();
    Properties env = new Properties();
    env.put(Context.PROVIDER_URL, jmsBrokerUrl);
    env.put(Context.INITIAL_CONTEXT_FACTORY, "org.apache.activemq.jndi.ActiveMQInitialContextFactory");
    jt.setEnvironment(env);
    jndiConfig.setJndiConnectionFactoryName("ConnectionFactory");
    jndiConfig.setEnvironment(env);
    conf.setJndiTemplate(jt);
    return conf;
}
```
conf.setTargetDestination("com.basistech.jug." + taskId);
conf.setJndiConfig(jndiConfig);
conf.setTimeToLive(0);
return conf;
}

JMSConfigFeature jmsConfigFeature = new JMSConfigFeature();
JMSConfiguration jmsConfig = JmsUtils.newJMSConfiguration(taskId, jmsBrokerUrl);
    jmsConfig.setConcurrentConsumers(maxServiceThreads);
    jmsConfig.setMaxConcurrentConsumers(maxServiceThreads);
    jmsConfigFeature.setJmsConfig(jmsConfig);
    svrFactory.getFeatures().add(jmsConfigFeature);
    svrFactory.getFeatures().add(jmsConfigFeature);

    server = svrFactory.create();

### JMSConfiguration options

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>connectionFactory</td>
<td>Mandatory field. Reference to a bean that defines a jms ConnectionFactory. Remember to wrap the connectionFactory like described above when not using a pooling ConnectionFactory.</td>
</tr>
<tr>
<td>wrapInSingleConnectionFactory</td>
<td>This option was removed since CXF 3.0.0. Will wrap the connectionFactory with a Spring SingleConnectionFactory, which can improve the performance of the jms transport. Default is true.</td>
</tr>
<tr>
<td>reconnectOnException</td>
<td>(deprecated) If wrapping the connectionFactory with a Spring SingleConnectionFactory and reconnectOnException is true, will create a new connection if there is an exception thrown, otherwise will not try to reconnect if the there is an exception thrown. Default is false. From CXF 3.0.0, CXF always reconnect on exceptions.</td>
</tr>
<tr>
<td>targetDestination</td>
<td>JNDI name or provider specific name of a destination. Example for ActiveMQ: test.cxf.jmstransport.queue</td>
</tr>
<tr>
<td>destinationResolver</td>
<td>Reference to a Spring DestinationResolver. This allows to define how destination names are resolved to jms Destinations. By default a DynamicDestinationResolver is used. It resolves destinations using the jms providers features. If you reference a JndiDestinationResolver you can resolve the destination names using JNDI.</td>
</tr>
<tr>
<td>transactionManager</td>
<td>Reference to a Spring transaction manager. This allows to take part in JTA Transactions with your webservice. You can also register a spring JMS Transaction Manager to have local transactions.</td>
</tr>
<tr>
<td>taskExecutor</td>
<td>This option was removed since CXF 3.0.0. Reference to a Spring TaskExecutor. This is used in listeners to decide how to handle incoming messages. Default is a Spring SimpleAsyncTaskExecutor.</td>
</tr>
<tr>
<td>useJms11</td>
<td>This option was removed since CXF 3.0.0. true means JMS 1.1 features are used false means only JMS 1.0.2 features are used. Default is false.</td>
</tr>
<tr>
<td>messageIdEnabled</td>
<td>Default is true. This option was removed since CXF 3.0.0.</td>
</tr>
<tr>
<td>messageTimestampEnabled</td>
<td>Default is true. This option was removed since CXF 3.0.0.</td>
</tr>
<tr>
<td>cacheLevel</td>
<td>This option was removed since CXF 3.0.0. Specify the level of caching that the JMS listener container is allowed to apply. (Default is -1) Please check out the java doc of the org.springframework.jms.listener. DefaultMessageListenerContainer for more information.</td>
</tr>
<tr>
<td>pubSubNoLocal</td>
<td>If true do not receive your own messages when using topics. Default is false.</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>receiveTimeout</td>
<td>How many milliseconds to wait for response messages. 0 (default) means wait indefinitely. Since CXF 3.0, the default value is changed to 60000 (60 seconds)</td>
</tr>
<tr>
<td>explicitQosEnabled</td>
<td>If true, means that QoS parameters are set for each message. (Default is false.)</td>
</tr>
<tr>
<td>deliveryMode</td>
<td>NON_PERSISTENT = 1 messages will only be kept in memory PERSISTENT = 2 (default) messages will be persisted to disk</td>
</tr>
<tr>
<td>priority</td>
<td>Priority for the messages. Default is 4. See your JMS provider doc for details.</td>
</tr>
<tr>
<td>timeToLive</td>
<td>After this time the message will be discarded by the jms provider. Default is 0.</td>
</tr>
<tr>
<td>sessionTransacted</td>
<td>If true, means JMS transactions are used. Default is false. In 2.7.x you will also need to register a JMS Transaction Manager with JMSConfiguration in order for transactions to be enabled.</td>
</tr>
<tr>
<td>concurrentConsumers</td>
<td>This option was removed since CXF 3.0.0. Minimum number of concurrent consumers for listener (default is 1).</td>
</tr>
<tr>
<td>maxConcurrentConsumers</td>
<td>This option was removed since CXF 3.0.0. Maximum number of concurrent consumers for listener (default 1).</td>
</tr>
<tr>
<td>maxConcurrentTasks</td>
<td>This option was removed since CXF 3.0.0. (deprecated) Maximum number of threads that handle the received requests. Default 10.</td>
</tr>
<tr>
<td>messageSelector</td>
<td>JMS selector to filter incoming messages (allows to share a queue)</td>
</tr>
<tr>
<td>subscriptionDurable</td>
<td>Default is false.</td>
</tr>
<tr>
<td>durableSubscriptionName</td>
<td></td>
</tr>
<tr>
<td>messageType</td>
<td>Text (default) binary byte</td>
</tr>
<tr>
<td>pubSubDomain</td>
<td>False (default) means use queues true means use topics</td>
</tr>
<tr>
<td>jmsProviderTibcoEms</td>
<td>True means that the jms provider is Tibco EMS. Default is false. Currently this activates that the principal in the SecurityContext is populated from the header JMS_TIBCO_SENDER. (available from cxf version 2.2.6)</td>
</tr>
<tr>
<td>maxSuspendedContinuations</td>
<td>Since CXF 3.0.0. The max suspended continuations that the JMS destination could have, if the current suspended continuations number exceeds the max value, the JMSListenerContainer will be stopped. The default value is -1, which means disable this feature.</td>
</tr>
<tr>
<td>reconnectPercentOfMax</td>
<td>Since CXF 3.0.0, If the JMSListenerContainer is stopped due to the current suspended continuation exceeds the max value, the JMSListenerContainer will be restarted when the current suspended continuation below the value of (maxSuspendedContinuations*reconnectPercentOfMax/100). The default value is 70.</td>
</tr>
<tr>
<td>createSecurityContext</td>
<td>(Since 2.7.14, 3.0.3) True (default) means create user security context for incoming messages.</td>
</tr>
<tr>
<td>propogateExceptions</td>
<td>(Since 2.7.15) 2.7.x only True (default) means that any exceptions occurring while processing the incoming message will be propagated. This setting is only relevant when a transaction manager and sessionTransacted are set.</td>
</tr>
</tbody>
</table>

### 2.5.3. UDP Transport

CXF provides a transport plugin to support transporting small (under about 60K) message payloads over UDP. It supports both unicast and multicast packet transfers. To use the UDP transport, you just need to include the cxf-rt-transports-udp module on the classpath and use a “udp://host:port” style URL for the address:
JaxWsServerFactoryBean factory = new JaxWsServerFactoryBean();
factory.setBus(getStaticBus());
factory.setAddress("udp://localhost:8888");
factory.setServiceBean(new GreeterImpl());
server = factory.create();

That will start the server on localhost UDP port 8888. You can also omit the hostname (udp://:8888) to bind to all the addresses or use one of the multicast addresses (example: udp://239.255.255.250:3702) to respond to the appropriate broadcasts.

For client configuration, similar to the server side, you just need to use the appropriate UDP url in order for the client to use UDP. If the hostname is specified in the URL, the Datagram will be sent directly to the host:port. If the hostname is not specified, the Datagram will be sent as a broadcast to the specific port. If the hostname is a multicast address, the Datagram will be sent Multicast to the given port.

UDP is different than the other CXF transports in that it allows multiple responses to be received for a single request. For example, if you send out a request via a multicast or broadcast, several servers could respond to that request. The basic JAX-WS generated interfaces only allow a single response to be returned to the application. However, if you use the JAX-WS Asynchronous methods, you can have CXF call the AsyncHandler for each response. To enable this, set the request property "udp.multi.response.timeout" to a timeout value greater than 0. CXF will wait that long for responses to come in before returning back to the application.

// wait 3 seconds for responses
((BindingProvider)proxy).getRequestContext().put(
    "udp.multi.response.timeout", 3000);
proxy.greetMeAsync("World", new AsyncHandler<String>() {
    public void handleResponse(Response<Object> res) {
        System.out.println(res.get());
    }
});

The CXF SOAP binding supports the use of the SOAP over UDP specification URL's for transporting SOAP messages over UDP. Just using “soap.udp” as the scheme part of the UDP URL (instead of just “udp”) will enable the SOAP over UDP support. The main difference between using the pure UDP CXF transport and the SOAP over UDP support is that SOAP over UDP requires the use of WS-Addressing headers whereas the pure CXF UDP transport does not. The WS-Addressing header can add significant size to the SOAP messages. With UDP limiting the size of the packets to under 64K, that can be significant.

2.6. WS-* Support

2.6.1. WS-Addressing

2.6.1.1. WS-Addressing via XML Configuration / Java API

CXF provides support for the 2004-08 and 1.0 versions of WS-Addressing.
To enable WS-Addressing you may enable the WSAddressingFeature on your service. If you wish to use XML to configure this, you may use the following syntax:

```xml
<jaxws:endpoint id="{your.service.namespace}YourPortName">
    <jaxws:features>
    </jaxws:features>
</jaxws:endpoint>
```

You can also use the same exact syntax with a `<jaxws:client>`

```xml
<jaxws:client id="{your.service.namespace}YourPortName">
    <jaxws:features>
    </jaxws:features>
</jaxws:client>
```

From an API point of view this looks very similar:

```java
import org.apache.cxf.jaxws.EndpointImpl;
import org.apache.cxf.ws.addressing.WSAddressingFeature;

MyServiceImpl implementor = new MyServiceImpl();
EndpointImpl ep = (EndpointImpl) Endpoint.create(implementor);
ep.getFeatures().add(new WSAddressingFeature());
ep.publish("http://some/address");
```

You can also use it with the ClientProxyFactoryBeans and ServerFactoryBeans (and their JAX-WS versions, namely JaxWsProxyFactoryBean and JaxWsServerFactoryBean):

```java
import org.apache.cxf.frontend.simple.ClientProxyFactoryBean;
import org.apache.cxf.ws.addressing.WSAddressingFeature;

ClientProxyFactoryBean factory = new ClientProxyFactoryBean();
factory.setServiceClass(MyService.class);
factory.setAddress("http://acme.come/some-service");
factory.getFeatures().add(new WSAddressingFeature());
MyService client = (MyService) factory.create();
```

### 2.6.1.2. Enabling WS-Addressing with WS-Policy

If you’re using **WS-Policy**, CXF can automatically set up WS-Addressing for you if you use the `<Addressing>` policy expression.

### 2.6.1.3. Decoupled responses

By default, WS-Addressing using anonymous Reply-To addresses. This means the request/response patterns are synchronous in nature and the response will be sent back via the normal reply channel. However, WS-Addressing allows for a decoupled endpoint to be used for receiving the response with CXF then correlating it with the appropriate request. There are a few ways for configuring the address on which CXF will listen for decoupled WS-Addressing responses. For HTTP conduit configuration, its client configuration has an option for a DecoupledEndpoint address. If the conduit has this configured, all requests sent via that conduit will have WS-Addressing enabled and their responses sent to that endpoint:
The address can also be set via a Request Context property:

```java
((BindingProvider)proxy).getRequestContext()
    .put("org.apache.cxf.ws.addressing.replyto",
         "http://localhost:9090/decoupled_endpoint");
```

The CXF AddressingPropertiesImpl object can be used to control many aspects of WS-Addressing including the Reply-To:

```java
AddressingProperties maps = new AddressingPropertiesImpl();
EndpointReferenceType ref = new EndpointReferenceType();
AttributedURIType add = new AttributedURIType();
add.setValue("http://localhost:9090/decoupled_endpoint");
ref.setAddress(add);
maps.setReplyTo(ref);
maps.setFaultTo(ref);

((BindingProvider)port).getRequestContext()
    .put("javax.xml.ws.addressing.context", maps);
```

This method can also be used to configure the namespace (version) of the WS-Addressing headers, exact message ID's, and similar information.

### 2.6.2. WS-Discovery

**WS-Discovery** is a protocol to enable dynamic discovery of services available on the local network. By default, WS-Discovery uses a UDP based multicast transport to announce new services and probe for existing services. However, it also supports a managed mode where a discovery proxy is used to reduce the amount of multicast traffic required.

To enable CXF to send "Hello" announcements when services and endpoint are started, the cxf-services-ws-discovery-service and cxf-services-ws-discovery-api jars need to be available on the classpath. The cxf-services-ws-discovery-service jar will register a ServerLifecycleListener that will automatically publish the "Hello" messages. It will also respond to any Probe requests that match the services it has published.

By default, the WS-Discovery service will startup in ad-hoc mode. However, if you set a Bus property of "org.apache.cxf.service.ws-discovery.address" to a URL address of a WS-Discovery Proxy, the service will change to managed mode and send the Hello/Bye notices directly to that proxy. It will also not respond to Probes.

CXF also provides an API to probe the network or WS-Discovery proxy. The WSDiscoveryClient class (shown below) provides several methods for probing the network.

```java
import org.apache.cxf.ws.discovery.WSDiscoveryClient;
...
// Use WS-Discovery to find references to services
// that implement the Greeter portType
WSDiscoveryClient client = new WSDiscoveryClient();
   // or: new WSDiscoveryClient("soap.udp://proxyhost:3702");
```
List<EndpointReference> references =
    client.probe(new QName("http://cxf.apache.org/hello_world/discovery",
    "Greeter"));
client.close();

GreeterService service = new GreeterService();
// loop through all of them and have them greet me.
for (EndpointReference ref : references) {
    Greeter g = service.getPort(ref, Greeter.class);
    System.out.println(g.greetMe("World"));
}

2.6.3. WS-Policy

2.6.3.1. Developing Assertions

There are two steps involved in developing your domain specific assertions, these are:

1. Implementing the Assertion and AssertionBuilder interfaces, and registering the
   AssertionBuilder with the AssertionBuilderRegistry

2. Providing runtime support for the Assertion, either in form of an interceptor or inside a conduit
   or a destination, and registering that support if necessary.

The steps are outlined in more detail below:

Implementing the Assertion Interface

You can chose to implement the Assertion interface from scratch, or decide to use one of the
existing Assertion implementations in the cxf-api module, extending them as required:

PrimitiveAssertion

This class represents an assertion without any attributes or child elements (in particular without
a nested Policy element). The AnonymousResponses or NonAnonymousResponses assertions
in the addressing metadata namespace http://www.w3.org/2007/01/addressing/metadata are
examples of this type of assertion. The implementation of the equal and normalize methods in
the class are trivial, and there should be no need to extend this class.

NestedPrimitiveAssertion

This class represents an assertion without any attributes, but with one mandatory nested Policy
child element. The Addressing assertions in the addressing metadata namespace is an example
of this type of assertion. The implementation of the equal and normalize methods are generic,
and there should be no need to extend this class.
JAX-WS Development

JaxbAssertion

This class represents an assertion described by an xml schema type that has been mapped to a Java class. The RM assertion as well as the assertions used in the HTTP module are extensions of this class. Although the equal and normalize methods are not abstract, you probably want to overwrite these methods.

Implementing and Registering the AssertionBuilder Interface

Assertion Builder class for custom assertion should implement AssertionBuilder<T> interface. The interface type can be Element, XMLStreamReader or OMElement.

Interface contains two methods: build() and getKnownElements().

Implementation of build() method should construct Assertion from the incoming type. It can be PrimitiveAssertion (without attributes or child elements), NestedPrimitiveAssertion (without attributes but with nested policy element) and JaxbAssertion (assertion described by any XML schema).

getKnownElements() method must return QNames of assertion elements from which assertion can be built.

Implementing the build method of the AssertionBuilder interface is straightforward (in the case of JaxbAssertions you can extend the JaxbAssertionBuilder class, which provides an appropriate JAXB context and some other useful methods).

The implementation of buildCompatible may need some more consideration if your assertion represents an element with attributes and/or child elements.

Registration of your AssertionBuilder with the AssertionBuilderRegistry is easy enough: simply add a bean for your AssertionBuilder to the cxf-* file of your module, or to the application’s custom cfg file.

Implementing a Policy-Aware Interceptor

This is the easiest way of providing runtime support for an Assertion. Steps 1. and 2. listed in Interaction with the Framework can usually be coded as follows:

```java
package mycompany.com.interceptors;
import org.apache.cxf.ws.policy.AssertionInfoMap;

class MyPolicyAwareInterceptor {
    static final QName assertionType = new QName("http://mycompany.com", "MyType");
    public void handleMessage(Message message) {
        // get AssertionInfoMap
        org.apache.cxf.ws.policy.AssertionInfoMap aim = 
            message.get(org.apache.cxf.ws.policy.AssertionInfoMap.class);
        Collection<AssertionInfo ais> = aim.get(assertionType );
    }
}
```
Sometimes, it may be more convenient to spread the above functionality across several interceptors, possibly according to chain (in, in fault, out, outfault). In any case, you need to also provide a PolicyInterceptorProvider, and declare a corresponding bean. Either implement one from scratch or use the PolicyInterceptorProviderImpl in the api package and customise it as follows (assuming that one and the same interceptor is used for all paths). The main task of policy interceptor provider is to say which interceptors must be activated for specified policy assertion:

```xml
<bean name="MyPolicyAwareInterceptor"
  class="mycompany.com.interceptors.MyPolicyAwareInterceptor"/>
<bean class="org.apache.cxf.ws.policy.PolicyInterceptorProviderImpl">
  <constructor-arg>
    <!-- the list of assertion types supported by this PolicyInterceptorProvider -->
    <list>
      <bean class="javax.xml.namespace.QName">
        <constructor-arg value="http://mycompany.com}MyType"/>
      </bean>
    </list>
  </constructor-arg>
  <property name="inInterceptors">
    <list>
      <ref bean="MyPolicyAwareInterceptor"/>
    </list>
  </property>
  <property name="inFaultInterceptors">
    <list>
      <ref bean="MyPolicyAwareInterceptor"/>
    </list>
  </property>
  <property name="outInterceptors">
    <list>
      <ref bean="MyPolicyAwareInterceptor"/>
    </list>
  </property>
  <property name="outFaultInterceptors">
    <list>
      <ref bean="MyPolicyAwareInterceptor"/>
    </list>
  </property>
</bean>
```

All beans of type PolicyInterceptorProvider are automatically registered with the framework's PolicyInterceptorProviderRegistry.
It is also possible to implement policy interceptor provider programmatically from scratch. It’s constructor gives assertions QNames as argument of super constructor and adds corresponded interceptors using getters:

```java
public class MyInterceptorProvider extends AbstractPolicyInterceptorProvider {
    private static final long serialVersionUID = -5248428637449096540L;
    private static final MyInInterceptor IN_INTERCEPTOR = new MyInInterceptor();
    private static final MyOutInterceptor OUT_INTERCEPTOR = new MyOutInterceptor();
    private static final MyOutFaultInterceptor OUT_FAULT_INTERCEPTOR = new MyOutFaultInterceptor();

    private static final Collection<QName> ASSERTION_TYPES;
    static {
        ASSERTION_TYPES = new ArrayList<QName>();
        ASSERTION_TYPES.add(new QName("www.mycompany.org", "myassertion");
    }

    public MyInterceptorProvider() {
        super(ASSERTION_TYPES);
        getInInterceptors().add(IN_INTERCEPTOR);
        getOutInterceptors().add(OUT_INTERCEPTOR);
        getOutFaultInterceptors().add(OUT_FAULT_INTERCEPTOR);
    }
}
```

Since version 2.5.2, Assertion builder and policy interceptor provider can be registered using CXF bus extension mechanism: just create a file META-INF/cxf/bus-extensions.txt containing the following:

```plaintext
org.company.MyInterceptorProvider::true
org.company.MyAssertionBuilder::true
```

Boolean value at the end specifies lazy loading strategy.

CXF automatically recognizes the assertion builder and policy interceptor provider and store them into registries: `AssertionBuilderRegistry` and `PolicyInterceptorProviderRegistry`.

Since CXF 2.6.0 it is possible to register multiple interceptor providers for single assertion.

**Implementing a Policy-Aware Conduit/Destination**

**Initialization**

Conduits/Destinations have access to the EndpointInfo object in their their constructors. Assuming they also have access to the bus, they can at any time in their lifecycle obtain the effective policy for the endpoint as follows:

```java
class MyPolicyAwareConduit {
    static final QName assertionType = new QName("http://mycompany.com", "MyType");

    void init() {
        PolicyEngine engine = bus.getExtension(PolicyEngine.class);
        if (null != engine && engine.isEnabled()) {
```
EffectiveEndpointPolicy ep = engine.getEndpointPolicy(endpoint, this);
Collection<Assertion> as = ep.getChosenAlternative();
for (Assertion a : as) {
    if (assertType.equals(a.getName())) {
        // do something with it ...
    }
    ...
}
and similarly for a Destination.

Policy-Aware Message Sending

Given access to the Message object, a conduit can, in its send method, proceed the same way as an interceptor in handleMessage. It can defer the updating of the assertion status in the AssertionInfo objects until called upon by the PolicyVerificationOutInterceptor, i.e. implement the status update in the assertMessage method. If the status update takes place inside of the send method itself, assertMessage, at least for outbound messages, can be implemented as a no-op.

Implementing the Assertor Interface

With canAssert, the conduit/destination simply informs the framework if it understands a given type of assertions. In assertMessage on the other hand, the conduit/destination expresses support (or the lack thereof) for specific assertion instances. See Verification for a description of how this API is used by the verifying policy interceptors in the POST_STREAM or PRE_INVOC phases. HTTPConduit is an example of a policy aware Conduit. It supports assertions of type HTTPClientPolicy, which are represented in the runtime as JaxbAssertion<HTTPClientPolicy> objects. HTTPConduit also has a data member of type HTTPClientPolicy. It implements assertMessage as follows: for outbound messages, it asserts all JaxbAssertion<HTTPClientPolicy> that are compatible with this data member. For inbound messages, all HTTPClientPolicy assertions are asserted regardless their attributes. The rationale for this is that the semantics of the HTTPClientPolicy assertion effectively does not mandate any specific action on the inbound message. Similarly, on its inbound path, the HTTPDestination asserts all HTTPServerPolicy assertions that are equal to the HTTPServerPolicy assertion configured for the destination, and all assertions of that type on the outbound path.

class MyPolicyAwareConduit implements Assertor {
    static final QName MYTYPE = new QName("http://mycompany.com", "MyType");

    public boolean canAssert(QName name) {
        return MYTYPE.equals(name);
    }

    public void assertMessage(Mesage message) {
        AssertionInfoMap = message.get(AssertionInfoMap.class);
        ...
    }
}
2.6.3.2. How It Works

Retrieval of Policies

Policies are associated with policy subjects. In the web services context, there are four different subjects:

- Service
- Endpoint
- Operation
- Message

Using WSDL 1.1, the policy-subject association usually takes the form of **xml element attachment**: A wsp:Policy element (the wsp prefix denotes the http://www.w3.org/2006/07/ws-policy namespace) is attached to a WSDL element such as wsdl:port. Alternatively, a wsp:PolicyReference elements is attached to a wsdl element. In that case, the actual wsp:Policy element can reside outside of the wsdl. Note that subjects do not correspond to wsdl elements directly. Rather, they map to a set of wsdl elements (see below). For example wsdl:port, wsdl:portType and wsdl:binding elements together describe the endpoint as a subject.

Another form of associating policies with policy subjects is **external attachment**: wsp:PolicyAttachment elements, which can reside in arbitrary locations, explicitly specify the subject(s) they apply to in their AppliesTo child element.

In CXF, elements attached to a wsdl element are available as extensors in the service model representation of that wsdl element. wsp:Policy or wsp:PolicyReference elements can be obtained as extensors of type UnknownExtensibilityElement in which the element name matches that of the wsp:Policy or wsp:PolicyReference element. Note that these attached elements are not parsed when the service model is built. With xml element attachment in WSDL 1.1, given a Message object, wsp:Policy elements attached to the endpoint or message subject can therefore be obtained by navigating the service model starting with the OperationInfo and/or EndpointInfo object stored in the message (or in the exchange).

The location of documents containing PolicyAttachment documents on the other hand needs to be made known to the framework. This can easily be achieved through configuration, see **Specifying the Location of External Attachments**.

PolicyAttachments are flexible w.r.t. the type of domain expressions. Domain expressions are used to identify entities such as endpoints, operations or messages with which a policy can be associated:

```xml
<wsp:PolicyAttachment>
  <wsp:AppliesTo>
    <x:DomainExpression/> +
  </wsp:AppliesTo>
  <!-- wsp:Policy or wsp:PolicyReference elements -->
</wsp:PolicyAttachment>
```

Currently, CXF supports only domain expressions of type wsa:EndpointReferenceType: They allow to associate the policies or policy references in an attachment with an endpoint (by
means of matching the endpoint’s address with that in the EndpointReferenceType element). It is not possible however to associate a Policy with an operation or a message this way. Support for other types of domain expressions can be plugged in by implementing the DomainExpressionBuilder interface and adding a corresponding bean to your configuration file (all DomainExpressionBuilder instances loaded that way will automatically register with the DomainExpressionBuilder and thus be considered in the process of parsing PolicyAttachment elements).

Once that the framework knows where to look for wsp:Policy elements, it can parses these elements and creates runtime presentations for them. This is where AssertionBuilders come into play: All child elements of a wsp:Policy element that are not in the wsp namespace are considered to be assertions. The framework will use its AssertionBuilderFactory to find an AssertionBuilderFactory registered for the element type in question and, if it finds one, proceed to build an Assertion object from that element (or else throw a PolicyException).

**Computation of Effective Policies**

As mentioned above, policies are associated with policy subjects. With WSDL 1.1, the effective policy for a subject is the aggregation, or the merge, of the policies attached to the wsdl elements representing that subject: The effective policy for a service subject is the merge of all policies applying to the wsdl:service element. The effective policy for an endpoint subject is the merge of all policies applying to the wsdl:port, wsdl:portType and wsdl:binding elements. The effective policy for an operation subject is the merge of all policies applying to the wsdl:portType/wsdl:operation and wsdl:binding/wsdl:operation elements. The effective policy for a (input | output | fault) message subject is the merge of all policies applying to the wsdl:message, (wsdl:portType/wsdl:operation/wsdl:input | wsdl:portType/wsdl:operation/wsdl:output | wsdl:portType/wsdl:operation/wsdl:fault) and (wsdl:binding/wsdl:operation/wsdl:input | wsdl:binding/wsdl:operation/wsdl:output | wsdl:binding/wsdl:operation/wsdl:fault).

Additional aggregation takes place to determine the effective policy of an endpoint: The effective policy for a service is the effective policy for the service subject. The effective policy for an endpoint is the merge of the effective policies for the service subject and the endpoint subject. The effective policy for an operation is the merge of the effective policies for the service subject, the endpoint subject and the operation subject. The effective policy for a (input | output | fault) message is the merge of the effective policies for the service subject, the endpoint subject, the operation subject and the message subject.

**Multiple sources** can be used to apply policies to the same subject. In the case of an endpoint subject for example, its associated wsdl:port element can have multiple wsp:Policy child elements. Also, a separate document can contain wsp:PolicyAttachment elements in which the AppliesTo children identify the endpoint in question as the target subject. Both the Policies attached to the port element as well as those in the matching PolicyAttachment elements will then contribute to the effective policy of the endpoint subject.

It is also important to keep in mind that the aggregation process described above makes it possible for an effective policy to have **multiple assertion elements of the same type in one alternative** (although this would not be considered the normal case). Different assertions of the same type within the same alternative do not overwrite each other. In fact, if used inappropriately, they may contradict each other. But it is also possible that they complement each other. Either way, the framework does not remove such duplicates and instead leaves it to the interceptors (or other Assertors) involved in the assertion process to decide if they can meaningfully deal with multiple assertions of the same type.
It is obvious that the above aggregation process can be quite resource intense. Effective policies for messages and endpoints are therefore cached by the framework for future reference. The entity that manages the cache of effective policies is the PolicyEngine.

When computing the effective policy for an endpoint or a message, the framework also chooses one of the effective policy's alternatives. Currently, it chooses the first alternative in which all assertions may be supported, either by interceptors (i.e. there is a PolicyInterceptorProvider for the assertion type) or by the conduit/destination (if this implements the Assertor interface and through its canAssert method confirms that it can support the assertion type). However, even if such an alternative can be found, the chosen alternative is not necessarily supported: An interceptor may in principle be able to support a specific type of assertions, but it may not actually be able to support an individual instance of that assertion type.

The choice of alternative, along with the set of interceptors (obtained from the PolicyInterceptorProviders in the PolicyInterceptorProviderRegistry), is cached along with the actual effective message or endpoint policy in the form of an EffectivePolicy or EffectiveEndpointPolicy object. In the case of an effective endpoint policy, interceptors are chosen in such a way that the assertions in the chosen alternative of the effective endpoint policy can be supported, but also any assertion in any alternative of any of the operation and message specific policies. This is necessary in situations where the underlying message is not known, for example on the server inbound path: Once an alternative has been chosen for the effective policy of the server’s endpoint we know which assertions must definitely be supported, regardless the underlying message/operation. Additional interceptors that are necessary to support the assertions that only appear in specific operation or input message policies are added preemptively. Note that this generally requires interceptors to be coded defensively - good practice anyway but especially so for interceptors returned by PolicyInterceptorProviders!

### On-the-fly Provision of Interceptors

The policy framework, when activated (by loading the PolicyEngine and setting its "enabled" attribute to true), installs a couple of interceptors at bus level which execute early on in their respective interceptor chains:

<table>
<thead>
<tr>
<th>Role</th>
<th>Chain</th>
<th>Phase</th>
<th>Interceptor</th>
<th>Effective Policies Known</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Out</td>
<td>SETUP</td>
<td>ClientPolicy-OutInterceptor</td>
<td>Service, Endpoint, Operation, (Input) Message</td>
</tr>
<tr>
<td>Client</td>
<td>In</td>
<td>RECEIVE</td>
<td>ClientPolicy-InInterceptor</td>
<td>Service, Endpoint</td>
</tr>
<tr>
<td>Client</td>
<td>InFault</td>
<td>RECEIVE</td>
<td>ClientPolicy-InFault-Interceptor</td>
<td>Service, Endpoint</td>
</tr>
<tr>
<td>Server</td>
<td>In</td>
<td>RECEIVE</td>
<td>ServerPolicy-InFault-Interceptor</td>
<td>Service, Endpoint</td>
</tr>
</tbody>
</table>
The main purpose of these policy interceptors is to add further interceptors that are required to support the effective policy of the underlying message - even if that policy is not yet known at the time the policy interceptor executes (because the operation is not yet known at that time). If the effective message policy is known, the assertions of its selected alternative are inserted into the message in the form of an AssertionInfoMap. This is a map, keyed by assertion type name, of collections of AssertionInfo objects, the latter being stateful (asserted/not asserted) representations of Assertion objects. When the effective message policy is not known, not only the assertions for the selected alternative in the effective endpoint policy are included in the AssertionInfoMap, but also all assertions in all alternatives of all of the operation and message specific policies. Not all of these will be asserted at the end of the chain, but that is fine if it turns out the unasserted assertions apply to operation sayHi when in fact the chain has been processing the message for a greetMe request!

**Policy Aware Interceptors**

Policy-aware interceptors extract the collection of AssertionInfo objects for the assertion types they understand from the AssertionInfoMap in the message. They can then use the wrapped Assertion objects to fine tune their behaviour, possibly exhibiting message specific behaviour. They can also express whether or not they could support these assertions. Given an assertion type that has attributes, and assuming there are two instances of assertions of this type, it is possible that the interceptor can assert one, but not the other. In any case, inability to support all assertions understood by the interceptor does not necessarily indicate a failure. As mentioned above in relation to pre-emptive interceptor installation, it is possible that the ones that cannot be supported do not in fact apply to the underlying message at all. Typically the interceptor would strive at supporting as many of these assertions as possible however, and to do so it may avail of the AssertionBuilder’s capability to compute a compatible assertion. For example, by scheduling an acknowledgement to be sent in 3 seconds, an RM interceptor would support both of the following RMAssertions:

```xml
<wrmp:RMAssertion
 xmlns:wrmp="http://schemas.xmlsoap.org/ws/2005/02/rm/policy">
 <wrmp:AcknowledgementInterval Milliseconds="30000"/>
</wrmp:RMAssertion>
<wrmp:RMAssertion
 xmlns:wrmp="http://schemas.xmlsoap.org/ws/2005/02/rm/policy">
 <wrmp:AcknowledgementInterval Milliseconds="50000"/>
</wrmp:RMAssertion>
```

**Verification**

Another set of interceptors installed by the policy framework is responsible for verifying that one of the alternatives in the effective policy of the underlying message is indeed supported. These interceptors are:

<table>
<thead>
<tr>
<th>Chain</th>
<th>Phase</th>
<th>Interceptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out, OutFault</td>
<td>POST_STREAM</td>
<td>PolicyVerificationOutInterceptor</td>
</tr>
<tr>
<td>In</td>
<td>PRE_INVOKE</td>
<td>PolicyVerificationInInterceptor</td>
</tr>
<tr>
<td>InFault</td>
<td>PRE_INVOKE</td>
<td>PolicyVerificationInFaultInterceptor</td>
</tr>
</tbody>
</table>
Their behaviour is symmetric on client and server side. On the outbound chain the effective message policy was known by the time the policy interceptor executing in the SETUP phase had inserted the AssertionInfoMap into the message. As the map was built exclusively from the Assertion objects that are part of the chosen alternative of the effective message policy, all of them must be supported. In other words, all of the AssertionInfo objects need to be in the asserted state. If one of them is not, the interceptor throws a Fault (wrapping a PolicyException).

On the inbound paths a little bit more work is necessary: If the message is a fault, we know by now what type of fault it is and what operation it applies to. If the message is not a fault message, knowing the underlying operation we can, from the location of the interceptor (client or server side), infer the message subject (input or output message). Either way, all information is now available to obtain the effective message policy. To check if any of its alternatives is supported, the policy verification interceptors then simply check if for each of its assertions the associated AssertionInfo object in the map is in the asserted state. If no alternative is supported, the interceptor throws a Fault (wrapping a PolicyException).

One thing worth noting is that - both on outbound and inbound chains - there may be assertions that only the conduit or destination can support. Although conduit or destination could access Assertion objects and tailor their behaviour when sending or receiving the current message, it is not known at this point whether this “tailoring” actually succeeded for the underlying message, i.e. whether the assertions in questions could actually be supported. For this reason, the policy verification interceptors check if the conduit or destination implements the Assertor interface. If it does, they pass it the Message object so they confirm their support (or the lack thereof) for these assertions. The above described traversal of the AssertionInfo map only takes place after the conduit or destination had a chance to make their contribution.

2.6.3.3. WS-Policy Framework Overview

The WS-Policy framework provides infrastructure and APIs that allow CXF users and developers to use WS-Policy.

It is compliant with the November 2006 draft publications of the Web Services Policy 1.5 - Framework and Web Services Policy 1.5 - Attachment specifications.

The framework consists of a core runtime and APIs that allow developers to plug in support for their own domain assertions:

Core

The core is responsible for:

- retrieval of policies from different sources (wsdl documents, external documents)
- computation of effective policies for service, endpoint, operation and message objects
- on-the-fly provision of interceptors based on the effective policies for a particular message
- verification that one of the effective policy’s alternatives is indeed supported.

Policy operations such as merge and normalization (but not intersection) are based on Apache Neethi.
## APIs

### AssertionBuilder

The AssertionBuilder API is a concept from Neethi, slightly modified to avoid the dependency on the Axis object model, and extended to include support for domain specific behaviour of intersection and comparison.

```java
public interface AssertionBuilder {
    // build an Assertion object from a given DOM element
    Assertion build(Element element);
    // return the schema type names of assertions understood by this builder
    Collection<QName> getSupportedTypes();
    // return an Assertion object that is
    // compatible with the specified assertions
    Assertion buildCompatible(Assertion a, Assertion b);
}
```

AssertionBuilder implementations are loaded dynamically and are automatically registered with the AssertionBuilderRegistry, which is available as a Bus extension. Currently, CXF supports AssertionBuilder and Assertion implementations for the following assertion types:

- `{http://schemas.xmlsoap.org/ws/2005/02/rm/policy}` RMAssertion
- `{http://www.w3.org/2007/01/addressing/metadata}` Addressing
- `{http://www.w3.org/2007/01/addressing/metadata}` AnonymousResponses
- `{http://www.w3.org/2007/01/addressing/metadata}` NonAnonymousResponses
- `{http://cxf.apache.org/transports/http/configuration}` client
- `{http://cxf.apache.org/transports/http/configuration}` server

along with the WS-SecurityPolicy defined assertions.

They are all based on generic Assertion implementations (PrimitiveAssertion, NestedPrimitiveAssertion, JaxbAssertion) that developers can parameterize or extend when developing their own assertions, see Developing Assertions.

### PolicyInterceptorProvider

This API is used to automatically engage interceptors required to support domain specific assertions at runtime, thus simplifying interceptor configuration a lot.

```java
public interface PolicyInterceptorProvider extends InterceptorProvider {
    // return the schema types of the assertions that can be supported
    Collection<QName> getAssertionTypes();
}
```

Currently, CXF supports PolicyInterceptorProvider implementations for the following assertion types:

- `{http://schemas.xmlsoap.org/ws/2005/02/rm/policy}` RMAssertion
- `{http://www.w3.org/2007/01/addressing/metadata}` Addressing
- `{http://www.w3.org/2007/01/addressing/metadata}` AnonymousResponses
- `{http://www.w3.org/2007/01/addressing/metadata}` NonAnonymousResponses

along with the WS-SecurityPolicy defined assertions.
In addition, the framework offers an API to refine domain expression(s) (XML elements describing policy subjects within a policy scope) in policy attachments. There is currently only one implementation for EndpointReferenceType domain expressions (matching over the address). Another implementation, using XPath expressions, is in work.

**Interaction with the Framework**

Components interact with the policy framework mainly in order to:

1. retrieve the assertions pertaining to the underlying message (at least the ones known to the component) so the component can operate on the message accordingly
2. confirm that the assertions pertaining to the underlying message are indeed supported.

Like most other CXF features, the policy framework is itself largely interceptor based. Thus, most interaction with the framework is indirect through the Message object: Policy interceptors make AssertionInfo objects (stateful representations of assertions) available to subsequently executing, policy-aware interceptors by inserting them into the Message object. Extracting the AssertionInfo objects from the Message allows interceptors to perform steps 1. and 2. above:

```java
import org.apache.neethi.Assertion;

public class AssertionInfo {
  ...
  public boolean isAsserted() {...}
  public void setAsserted(boolean asserted) {...}
  public Assertion getAssertion() {...}
}
```

The WS-Addressing and WS-RM interceptors are examples for this style of interaction.

Sometimes, Conduits and destinations also want to assert their capabilities. But they cannot normally wait for Assertion information being made available to them via the Message object: Conduits may exhibit message specific behaviour (for example, apply message specific receive timeouts), but decisions made during the initialization phase may limit their capability to do so. And Destinations cannot normally exhibit message or operation specific behaviour at all. But both may still be able to support assertions in the effective endpoint’s policy.

Their interaction with the policy framework therefore typically involves the PolicyEngine through which they obtain the effective policy for the underlying endpoint (for step 1.):

```java
public interface PolicyEngine {
  ...
  EndpointPolicy getClientEndpointPolicy(EndpointInfo ei, Conduit conduit);
  EndpointPolicy getServerEndpointPolicy(EndpointInfo ei, Destination destination);
}
```

```java
public interface EndpointPolicy {
  ...
  Policy getPolicy();
  Collection<Assertion> getChosenAlternative();
}
```

To perform step 2. they implement the Assertor interface (namely its assertMessage method):
An example for policy aware conduits and destinations in CXF are the HTTP conduit and destination. They do support assertions of element type HTTPClientPolicy and HTTPServerPolicy respectively.

## 2.6.4. WS-ReliableMessaging

CXF supports the February 2005 version of the Web Services Reliable Messaging Protocol (WS-ReliableMessaging) specification. Like most other features in CXF, it is interceptor based. The WS-Reliable Messaging implementation consists of 4 interceptors in total:

<table>
<thead>
<tr>
<th>Interceptor</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>org.apache.cxf.ws.rm.RMOutInterceptor</td>
<td>Responsible for sending CreateSequence requests and waiting for their CreateSequenceResponse responses, and and aggregating the sequence properties (id and message number) for an application message.</td>
</tr>
<tr>
<td>org.apache.cxf.ws.rm.RMInInterceptor</td>
<td>Intercepting and processing RM protocol messages (these will not the application level), as well as SequenceAcknowledgments piggybacked on application messages.</td>
</tr>
<tr>
<td>org.apache.cxf.ws.rm.soap.RMSoapInterceptor</td>
<td>Encoding and decoding the RM headers</td>
</tr>
<tr>
<td>org.apache.cxf.ws.rm.soap.RetransmissionInterceptor</td>
<td>Responsible for creating copies of application messages for future resends.</td>
</tr>
</tbody>
</table>

### 2.6.4.1. Interceptor Based QOS

The presence of the RM interceptors on the respective interceptor chains alone will take care that RM protocol messages are exchanged when necessary. For example, upon intercepting the first application message on the outbound interceptor chain, the RMOutInterceptor will send a CreateSequence request and only proceed with processing the original application message after it has the CreateSequenceResponse response. Furthermore, the RM interceptors are responsible for adding the Sequence headers to the application messages and, on the destination side, extracting them from the message.

This means that no changes to application code are required to make the message exchange reliable!

You can still control sequence demarcation and other aspects of the reliable exchange through configuration however. For example, while CXF by default attempts to maximize the lifetime of a sequence, thus reducing the overhead incurred by the RM protocol messages, you can enforce the use of a separate sequence per application message by configuring the RM source's sequence termination policy (setting the maximum sequence length to 1). See the Reliable Messaging Configuration Guide for more details on configuring this and other aspects of the reliable exchange.
2.6.5. WS-SecureConversation

WS-SecureConversation support in CXF builds upon the WS-SecurityPolicy implementation to handle the SecureConversationToken policy assertions that could be found in the WS-SecurityPolicy fragment.

Note: Because the WS-SecureConversation support builds on the WS-SecurityPolicy support, this is currently only available to "wsdl first" projects.

One of the "problems" of WS-Security is that the use of strong encryption keys for all communication carries a hefty performance penalty on communication. WS-SecureConversation helps to alleviate that somewhat by allowing the client and service to use strong encryption at the start to negotiate a set of new security keys that will be used for further communication. This can be a huge benefit if the client needs to send many requests to the service. However, if the client only needs to send a single request and is then discarded, WS-SecureConversation is actually slower because the key negotiation requires an extra request/response to the server.

With WS-SecureConversation, there are two Security policies that come into effect:

1. The "outer" policy that describes the security requirements for interacting with the actual endpoint. This will contain a SecureConversationToken in it someplace.

2. The "bootstrap" policy that is contained in the SecureConversationToken. This policy is the policy in affect when the client is negotiating the SecureConversation keys.

Configuring the WS-SecurityPolicy properties for WS-SecureConversation works exactly like the configuration for straight WS-SecurityPolicy. The only difference is that there needs to be a way to specify which properties are intended for the bootstrap policy in the SecureConversationToken and which are intended for the actual service policy. To accomplish this, properties intended for the SecureConversationToken bootstrap policy are appended with ".sct". For example:

```xml
<jaxws:client name="{http://InteropBaseAddress/interop} ... XDC-SEES_IPingService" createdFromAPI="true">
  <jaxws:properties>
    <!-- properties for the external policy -->
    <entry key="ws-security.username" value="abcd"/>

    <!-- properties for SecureConversationToken bootstrap policy -->
    <entry key="ws-security.username.sct" value="efgh"/>
    <entry key="ws-security.callback-handler.sct" value="interop.client.KeystorePasswordCallback"/>
    <entry key="ws-security.encryption.properties.sct" value="etc/bob.properties"/>
  </jaxws:properties>
</jaxws:client>
```

Via the Java API, use code similar to the following:

```java
org.apache.cxf.endpoint.Client client;
client.getRequestContext().put("ws-security.username.sct", username);
client.getRequestContext().put("ws-security.password.sct", password);
```

Via the Java API, use code similar to the following:

```java
org.apache.cxf.endpoint.Client client;
client.getRequestContext().put("ws-security.username.sct", username);
client.getRequestContext().put("ws-security.password.sct", password);
```
Note: In most common cases of WS-SecureConversation, you won’t need any configuration for the service policy. All of the "hard" stuff is used for the bootstrap policy and the service provides new keys for use by the service policy. This keeps the communication with the service itself as simple and efficient as possible.

2.6.6. WS-Security

2.6.6.1. WS-Security

WS-Security provides means to secure your services above and beyond transport level protocols such as HTTPS. Through a number of standards such as XML-Encryption, and headers defined in the WS-Security standard, it allows you to:

- Pass authentication tokens between services
- Encrypt messages or parts of messages
- Sign messages
- Timestamp messages

CXF relies on WSS4J in large part to implement WS-Security. Within your own services, WS-Security can be activated by using WS-SecurityPolicy, which provides a comprehensive and sophisticated validation of the security properties of a received message. A non-WS-SecurityPolicy approach is usually also possible by way of CXF interceptors added to your service and/or client as detailed in this section.

2.6.6.2. Overview of encryption and signing

WS-Security makes heavy use of public/private key cryptography. To really understand how to configure WS-Security, it is helpful - if not necessary - to understand these basics. The Wikipedia has an excellent entry on this, but we’ll try to summarize the relevant basics here (This content is a modified version of the Wikipedia content.)

With public key cryptography, a user has a pair of public and private keys. These are generated using a large prime number and a key function.

[Diagram of key generation process]
The keys are related mathematically, but cannot be derived from one another. With these keys we can encrypt messages. For example, if Bob wants to send a message to Alice, he can encrypt a message using her public key. Alice can then decrypt this message using her private key. Only Alice can decrypt this message as she is the only one with the private key.

Messages can also be signed. This allows you to ensure the authenticity of the message. If Alice wants to send a message to Bob, and Bob wants to be sure that it is from Alice, Alice can sign the message using her private key. Bob can then verify that the message is from Alice by using her public key.

2.6.6.3. Configuring the WSS4J Interceptors

To enable WS-Security within CXF for a server or a client, you’ll need to set up the WSS4J interceptors. You can either do this via the API for standalone web services or via Spring XML configuration for servlet-hosted ones. This section will provide an overview of how to do this, and the following sections will go into more detail about configuring the interceptors for specific security actions.

It is important to note that:

1. If you are using CXF 2.0.x, you must add the SAAJ(In/Out)Interceptors if you’re using WS-Security (This is done automatically for you from CXF 2.1 onwards). These enable creation of a DOM tree for each request/response. The support libraries for WS-Security require DOM trees.
2. The web service provider may not need both in and out WS-Security interceptors. For instance, if you are just requiring signatures on incoming messages, the web service provider will just need an incoming WSS4J interceptor and only the SOAP client will need an outgoing one.

Adding the interceptors via the API

On the Server side, you’ll want to add the interceptors to your CXF Endpoint. If you’re publishing your service using the JAX-WS APIs, you can get your CXF endpoint like this:

```java
import org.apache.cxf.endpoint.Endpoint;
import org.apache.cxf.jaxws.EndpointImpl;

EndpointImpl jaxWsEndpoint =
    (EndpointImpl) Endpoint.publish("http://host/service", myServiceImpl);
Endpoint cxfEndpoint = jaxWsEndpoint.getServer().getEndpoint();
```

If you’ve used the (JaxWs)ServerFactoryBean, you can simply access it via the Server object:

```java
import org.apache.cxf.endpoint.Endpoint;
import org.apache.cxf.endpoint.Server;
import org.apache.cxf.frontend.ServerFactoryBean;
ServerFactoryBean factory = ...;
...
Server server = factory.create();
Endpoint cxfEndpoint = server.getEndpoint();
```

On the client side, you can obtain a reference to the CXF endpoint using the ClientProxy helper:

```java
GreeterService gs = new GreeterService();
Greeter greeter = gs.getGreeterPort();
...
org.apache.cxf.endpoint.Client client =
    org.apache.cxf.frontend.ClientProxy.getClient(greeter);
org.apache.cxf.endpoint.Endpoint cxfEndpoint = client.getEndpoint();
```

Now you’re ready to add the interceptors:

```java
import org.apache.cxf.ws.security.wss4j.WSS4JInInterceptor;
import org.apache.cxf.ws.security.wss4j.WSS4JOutInterceptor;
...
Map<String,Object> inProps = new HashMap<String,Object>();
... // how to configure the properties is outlined below;
WSS4JInInterceptor wssIn = new WSS4JInInterceptor(inProps);
cxfEndpoint.getInInterceptors().add(wssIn);
Map<String,Object> outProps = new HashMap<String,Object>();
... // how to configure the properties is outlined below;
WSS4JOutInterceptor wssOut = new WSS4JOutInterceptor(outProps);
cxfEndpoint.getOutInterceptors().add(wssOut);
```
2.6.6.4. Spring XML Configuration

If you’re using Spring to build endpoints (e.g., web services running on a servlet container such as Tomcat), you can easily accomplish the above using your bean definitions instead.

```xml
<import resource="classpath:META-INF/cxf/cxf.xml" />
<import resource="classpath*:META-INF/cxf/cxf-extension-*.xml" />

<jaxws:endpoint id="myService"
    implementor="com.acme.MyServiceImpl"
    address="http://localhost:9001/MyService">
    <bean id="myPasswordCallback"
        class="com.mycompany.webservice.ServerPasswordCallback"/>
    <jaxws:inInterceptors>
        <bean class="org.apache.cxf.ws.security.wss4j.WSS4JInInterceptor">
            <constructor-arg>
                <map>
                    <entry key="action" value="UsernameToken"/>
                    <entry key="passwordType" value="PasswordDigest"/>
                    <entry key="signaturePropFile" value="..."/>
                    <entry key="passwordCallbackRef">
                        <ref bean="myPasswordCallback"/>
                    </entry>
                </map>
            </constructor-arg>
        </bean>
    </jaxws:inInterceptors>
</jaxws:endpoint>
```

The entry keys and values given in the constructor-arg element above (action, signaturePropFile, etc.) map to the text strings in WS4J’s [WSHandlerConstants](http://www.springframework.org/schema/util) and [WSClalnstants](http://www.springframework.org/schema/util/WSClalnstants.xsd) classes for the corresponding WSHandlerConstants.XXXXX and WSClalnstants.XXXXX constants you see in the section below. So by viewing WSHandlerConstants, for example, you can see that the WSHandlerConstants.USERNAME_TOKEN value given below would need to be "UsernameToken" instead when doing Spring configuration.

If you want to avoid looking up the text keys for the WSHandlerConstants.XXXXX and WSClalnstants.XXXXX constants, you can also use the Spring util namespace to reference static constants in your Spring context as shown below.

```xml
<beans
    xmlns:util="http://www.springframework.org/schema/util"
    xsi:schemaLocation="...
    <bean class="org.apache.cxf.ws.security.wss4j.WSS4JInInterceptor">
        <constructor-arg>
            <map>
                <entry value="UsernameToken">
                    <key>
                        <util:constant static-field=..."/>
                </entry>
            </map>
        </constructor-arg>
    </bean>
</beans>
```
Additional Configuration Options

While the CXF WSS4J interceptors support the standard configuration properties available in WSHandlerConstants.XXXXX and W5Constants.XXXX, CXF also provides access to some additional low level configuration capabilities in WSS4J and some other security related interceptors.

Validating Signature and/or Encryption of Message Contents

As of CXF 2.2.8, the CryptoCoverageChecker interceptor allows one to validate signature and encryption coverage of message contents without migrating to a WS-SecurityPolicy based configuration. The interceptor can support enforcement of signature and encryption coverage at both the element and content level (be aware that the combination of signature and content do not represent a valid combination of coverage type and coverage scope). To configure this interceptor using the API, follow the example below.

```java
import org.apache.cxf.ws.security.wss4j.CryptoCoverageChecker;
import org.apache.cxf.ws.security.wss4j.CryptoCoverageChecker.XPathExpression;
import org.apache.cxf.ws.security.wss4j.CryptoCoverageUtil.CoverageType;

Map<String, String> prefixes = new HashMap<String, String>();
    prefixes.put("ser", "http://www.sdj.pl");
    prefixes.put("soap", "http://schemas.xmlsoap.org/soap/envelope/");

List<XPathExpression> xpaths = Arrays.asList(
    new XPathExpression("//ser:Header", CoverageType.SIGNED, CoverageScope.ELEMENT),
    new XPathExpression("//soap:Body", CoverageType.ENCRYPTED, CoverageScope.CONTENT));

CryptoCoverageChecker checker = new CryptoCoverageChecker(prefixes, xpaths);
```

The interceptor can also be configured in Spring using the conventional bean definition format.

After configuring the interceptor as above, simply add the interceptor to your client or server interceptor chain as shown previously with the WSS4J interceptors. Ensure that you include the WSS4JInInterceptor in the chain or all requests will be denied if you enforce any coverage XPaths.

The CryptoCoverageChecker is somewhat complex to set up for the most common use-cases for signature verification and decryption, as it involves adding XPath expressions and the
corresponding prefix/namespace pairs. The DefaultCryptoCoverageChecker provides an easy way to ensure that the SOAP Body is signed or encrypted, that the Timestamp is signed, and that the WS-Addressing ReplyTo and FaultTo headers are signed (if they are present in the message payload).

The default configuration is that the SOAP Body, (WSU) Timestamp and WS-Addressing ReplyTo and FaultTo headers must be signed (if they exist in the message payload). This provides an out-of-the-box way of preventing XML Signature wrapping attacks. All that is required is that the DefaultCryptoCoverageChecker be added to the in-interceptor chain. For example:

```
<jaxws:inInterceptors>
  <bean class="org.apache.cxf.ws.security.wss4j.WSS4JInInterceptor">
    <constructor-arg>
      <map>
        <entry key="action" value="Signature Timestamp"/>
        <entry key="signaturePropFile" value="..."/>
        <entry key="passwordCallbackClass" value="..."/>
      </map>
    </constructor-arg>
  </bean>
  <bean class="org.apache.cxf.ws.security.wss4j.DefaultCryptoCoverageChecker"/>
</jaxws:inInterceptors>
```

**Custom Processors**

You can specify custom WSS4J Processor configuration on the WSS4JInInterceptor. To activate this configuration option, one provides a non-WSS4J defined property, wss4j.processor.map, to the WSS4JInInterceptor as shown in the following Spring example. The same configuration can be achieved through the API as well. The key value is an XML qualified name of the WS-Security header element to process with the given processor implementation. The entry values can be a String representing a class name of the processor to instantiate, an Object implementing Processor, or null to disable processing of the given WS-Security header element.

```
<bean class="org.apache.cxf.ws.security.wss4j.WSS4JInInterceptor">
  <constructor-arg>
    <map>
      ...
      <!-- This reconfigures the processor implementation that WSS4j uses to process a WS-Security Signature element. -->
      <entry key="wss4j.processor.map">
        <map key-type="javax.xml.namespace.QName">
          <entry value="my.class">
            <key>
              <bean class="javax.xml.namespace.QName">
                <constructor-arg value="http://www.w3.org/2000/09/xmldsig#"/>
                <constructor-arg value="Signature"/>
              </bean>
            </key>
          </entry>
        </map>
      </entry>
    </map>
  </constructor-arg>
</bean>
```
Custom Actions

You can specify custom WSS4J Action configurations on the WSS4JOutInterceptor. To activate this configuration option, one provides a non-WSS4J defined property, wss4j.action.map, to the WSS4JOutInterceptor as shown in the following Spring example. The same configuration can be achieved through the API as well. The key value is an integer representing the WSS4J action identifier. The entry values can be a String representing a class name of the action to instantiate or an Object implementing Action. This configuration option allows you to override built-in action implementations or add your own.

```xml
<bean class="org.apache.cxf.ws.security.wss4j.WSS4JOutInterceptor">
  <constructor-arg>
    <map>
      ...<!-- Redefines the action for SAMLTokenSigned to use a custom implementation. -->
      <entry key="wss4j.action.map">
        <map key-type="java.lang.Integer" value-type="java.lang.Object">
          <entry key="0x10" value-ref="mySamlTokenSignedAction"/>
        </map>
      </entry>
      ...</map>
    </map>
  </constructor-arg>
</bean>
```

2.6.6.5. Configuring WS-Security Actions

Username Token Authentication

WS-Security supports many ways of specifying tokens. One of these is the UsernameToken header. It is a standard way to communicate a username and password or password digest to another endpoint. Be sure to review the OASIS UsernameToken Profile Specification for important security considerations when using UsernameTokens. If a nonce is present in a UsernameToken then it should be cached by the message recipient to guard against replay attacks. This behaviour is enabled by default starting with CXF 2.6.0. This functionality is also available from Apache CXF 2.4.7 and 2.5.3 onwards, but is not enabled by default at all for backwards-compatibility reasons. The following properties control nonce caching:

- `ws-security.enable.nonce.cache` - The default value (for CXF 2.6.0) is “true” for message recipients, and “false” for message initiators. Set it to true to cache for both cases. The default value for CXF 2.4.x and 2.5.x is false.

- `ws-security.nonce.cache.instance` - This holds a reference to a ReplayCache instance used to cache UsernameToken nonces. The default instance that is used is the EHCacheReplayCache, which uses Ehcache to cache the nonce values.
• **ws-security.cache.config.file** - Set this property to point to a configuration file for the underlying caching implementation. By default the cxf-ehcache.xml file in the CXF rt-ws-security module is used.

For the server side, you’ll want to set up the following properties on your WSS4JInInterceptor (see above [129] for code sample):

```java
inProps.put(WSHandlerConstants.ACTION, WSHandlerConstants.USERNAME_TOKEN);
// Password type : plain text
inProps.put(WSHandlerConstants.PASSWORD_TYPE, WSConstants.PW_TEXT);
// for hashed password use:
// properties.put(WSHandlerConstants.PASSWORD_TYPE, WSConstants.PW_DIGEST);
// Callback used to retrieve password for given user.
inProps.put(WSHandlerConstants.PW_CALLBACK_CLASS, ServerPasswordHandler.class.getName());
```

The password callback class allows you to retrieve the password for a given user so that WS-Security can determine if they’re authorized. Here is a small example:

```java
import java.io.IOException;
import javax.security.auth.callback.Callback;
import javax.security.auth.callback.CallbackHandler;
import javax.security.auth.callback.UnsupportedCallbackException;
import org.apache.ws.security.WSPasswordCallback;

public class ServerPasswordCallback implements CallbackHandler {
    public void handle(Callback[] callbacks) throws IOException, UnsupportedCallbackException {
        WSPasswordCallback pc = (WSPasswordCallback) callbacks[0];

        if (pc.getIdentifier().equals("joe")) {
            // set the password on the callback.
            // This will be compared to the
            // password which was sent from the client.
            pc.setPassword("password");
        }
    }
}
```

Note that for up to and including CXF 2.3.x, the password validation of the special case of a plain-text password (or any other yet unknown password type) is delegated to the callback class, see org.apache.ws.security.processor.UsernameTokenProcessor#handleUsernameToken() method javadoc of the WSS4J project. In that case, the ServerPasswordCallback should be something like the following one:

```java
public class ServerPasswordCallback implements CallbackHandler {
    public void handle(Callback[] callbacks) throws IOException, UnsupportedCallbackException {
        WSPasswordCallback pc = (WSPasswordCallback) callbacks[0];

        if (pc.getIdentifier().equals("joe") {
            if (!pc.getPassword().equals("password")) {
                throw new IOException("wrong password");
            }
        }
    }
}
```
For CXF 2.4 onwards, the callback handler supplies the password for all cases, and the validation is done internally (but can be configured). See here for more information. On the Client side you’ll want to configure the WSS4J outgoing properties:

```java
outProps.put(WSHandlerConstants.ACTION, WSHandlerConstants.USERNAME_TOKEN); // Specify our username
outProps.put(WSHandlerConstants.USER, "joe"); // Password type : plain text
outProps.put(WSHandlerConstants.PASSWORD_TYPE, WSConstants.PW_TEXT); // for hashed password use:
//properties.put(WSHandlerConstants.PASSWORD_TYPE, WSConstants.PW_DIGEST);
// Callback used to retrieve password for given user.
outProps.put(WSHandlerConstants.PW_CALLBACK_CLASS, ClientPasswordHandler.class.getName());
```

Once again we’re using a password callback, except this time instead of specifying our password on the server side, we’re specifying the password we want sent with the message. This is so we don’t have to store our password in our configuration file.

```java
import java.io.IOException;
import javax.security.auth.callback.Callback;
import javax.security.auth.callback.CallbackHandler;
import javax.security.auth.callback.UnsupportedCallbackException;
import org.apache.ws.security.WSPasswordCallback;
public class ClientPasswordCallback implements CallbackHandler {
    public void handle(Callback[] callbacks) throws IOException, UnsupportedCallbackException {
        WSPasswordCallback pc = (WSPasswordCallback) callbacks[0];
        // set the password for our message.
        pc.setPassword("password");
    }
}
```

In the case of multiple users with different passwords, use the getIdentifier() method of WSPasswordCallback to obtain the username of the current SOAP request.

Here is an example of WS-Security implemented using annotations for interceptors (uses UsernameToken).

### Using X.509 Certificates

The X.509 Certificate Token Profile (pdf) provides another option for implementing WS-Security. For the Signature and Encryption actions, you’ll need to create a public & private key for the entities involved. You can generate a self-signed key pair for your development environment via the following steps. Keep in mind these will not be signed by an external authority like Verisign, so are inappropriate for production use.

1. Creating private key with given alias and password like “myAlias”/“myAliasPassword” in keystore (protected by password for security reasons)

```bash
keytool -genkey -alias myAlias -keypass myAliasPassword -keystore 
```
privatestore.jks -storepass keyStorePassword -dname "cn=myAlias" -keyalg RSA

The alias is simply a way to identify the key pair. In this instance we are using the RSA algorithm.

2. Self-sign our certificate (in production environment this will be done by a company like Verisign).

keytool -selfcert -alias myAlias -keystore privatestore.jks -storepass keyStorePassword -keypass myAliasPassword

3. Export the public key from our private keystore to file named key.rsa

keytool -export -alias myAlias -file key.rsa -keystore privatestore.jks -storepass keyStorePassword

4. Import the public key to new keystore:

keytool -import -alias myAlias -file key.rsa -keystore publicstore.jks -storepass keyStorePassword

So now we have two keystores containing our keys - a public one (publicstore.jks) and a private one (privatestore.jks). Both of them have keystore password set to keyStorePass (this not recommended for production but ok for development) and alias set to myAlias. The file key.rsa can removed from filesystem, since it used only temporarily. Storing keys in keystores is strongly advised because a keystore is protected by a password.

A more detailed description of key generation can be found here: http://java.sun.com/javase/6/docs/technotes/tools/solaris/keytool.html

How to create a production certificate can be found here: http://support.globalsign.net/en/objectsign/java.cfm

Signning

Signing a message is used to validate that the message could only have come from a certain sender, and that the message was not altered in transit. It involves the sender encrypting a digest (hash) of the message with its private key, and the recipient decrypting the hash with the sender's public key, and recalculating the digest of the message to make sure the message was not altered in transit (i.e., that the digest values calculated by both the sender and recipient are the same). For this process to occur you must ensure that the Client's public key has been imported into the server's keystore using keytool.

On the client side, our outgoing WS-Security properties will look like so (see above [129] for code sample):

```java
outProps.put(WSHandlerConstants.ACTION, "Signature");
outProps.put(WSHandlerConstants.USER, "myAlias");
outProps.put(WSHandlerConstants.PW_CALLBACK_CLASS, ClientCallbackHandler.class.getName());
outProps.put(WSHandlerConstants.SIG_PROP_FILE, "client_sign.properties");
```

The USER that is specified is the key alias for the client. The password callback class is responsible for providing that key's password.

For X.509 support you will normally have multiple actions, e.g. Encryption with Signature. For these cases, just space-separate the actions in the ACTION property as follows:
Alternatively, you may space-separate the string literals you see above in the Spring configuration (e.g., "Signature Encrypt")

Our client_sign.properties file contains several settings to configure WSS4J:

```java
outProps.put(WSHandlerConstants.ACTION,  
WSHandlerConstants.TIMESTAMP + " " +  
WSHandlerConstants.SIGNATURE + " " +  
WSHandlerConstants.ENCRYPT);
```

On the server side, we need to configure our incoming WSS4J interceptor to verify the signature using the Client's public key.

```java
inProps.put(WSHandlerConstants.ACTION, "Signature");
inProps.put(WSHandlerConstants.SIG_PROP_FILE, "server.properties");
```

Our server_sign.properties file contains several settings to configure WSS4J:

```java
org.apache.ws.security.crypto.merlin.keystore.type=jks  
org.apache.ws.security.crypto.merlin.keystore.password=keyStorePassword  
org.apache.ws.security.crypto.merlin.keystore.alias=myAlias  
org.apache.ws.security.crypto.merlin.keystore.file=client_keystore.jks
```

**Encryption**

Encryption involves the sender encrypting the message with the recipient's public key to ensure that only the recipient can read the message (only the recipient has its own private key, necessary for decrypting the message.) This requires the sender to have the recipient's public key in its keystore.

The process for encrypting is very similar to and indeed usually combined with the signature process above. Our WS-Security test sample provides an example of encrypting requests and responses.

**Security Best Practices**

Some guidelines are given at the WSS4J website about best practices when using WS-Security. It is recommended to study the guidelines carefully.

### 2.6.7. WS-SecurityPolicy

CXF 2.2 introduced support for using WS-SecurityPolicy to configure WSS4J instead of the custom configuration documented on the WS-Security page. However, all of the "background" material on the WS-Security page still applies and is important to know. WS-SecurityPolicy just provides an easier and more standards based way to configure and control the security requirements. With the security requirements documented in the WSDL as WS-Policy fragments, other tools such as .NET can easily know how to configure themselves to inter-operate with CXF services.
2.6.7.1. Enabling WS-SecurityPolicy

In CXF 2.2, if the cxf-rt-ws-policy and cxf-rt-ws-security modules are available on the classpath, the WS-SecurityPolicy stuff is automatically enabled. Since the entire security runtime is policy driven, the only requirement is that the policy engine and security policies be available.

If you are using the full “bundle” jar, all the security and policy stuff is already included.

2.6.7.2. Policy description

With WS-SecurityPolicy, the binding and/or operation in the wsdl references a WS-Policy fragment that describes the basic security requirements for interacting with that service. The WS-SecurityPolicy specification allows for specifying things like asymmetric/symmetric keys, using transports (https) for encryption, which parts/headers to encrypt or sign, whether to sign then encrypt or encrypt then sign, whether to include timestamps, whether to use derived keys, etc...

Basically, it describes what actions are necessary to securely interact with the service described in the WSDL.

However, the WS-SecurityPolicy fragment does not include “everything” that is required for a runtime to be able to create the messages. It does not describe things such as locations of key stores, user names and passwords, etc... Those need to be configured in at runtime to augment the WS-SecurityPolicy fragment.

2.6.7.3. Configuring the extra properties

There are several extra properties that may need to be set to provide the additional bits of information to the runtime.

<table>
<thead>
<tr>
<th>Table 2.1. User Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ws-security.username</strong></td>
</tr>
<tr>
<td><strong>ws-security.password</strong></td>
</tr>
<tr>
<td><strong>ws-security.signature.username</strong></td>
</tr>
<tr>
<td><strong>ws-security.encryption.username</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2.2. Callback Class and Crypto properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ws-security.callback-handler</strong></td>
</tr>
<tr>
<td><strong>ws-security.saml-callback-handler</strong></td>
</tr>
<tr>
<td><strong>ws-security.signature.properties</strong></td>
</tr>
<tr>
<td><strong>ws-security.encryption.properties</strong></td>
</tr>
</tbody>
</table>
A Crypto object to be used for signature. If this is not defined then “ws-security.signature.properties” is used instead.

A Crypto object to be used for encryption. If this is not defined then “ws-security.encryption.properties” is used instead.

<table>
<thead>
<tr>
<th>Constant</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws-security.validate.token</td>
<td>true</td>
<td>Whether to validate the password of a received UsernameToken or not.</td>
</tr>
<tr>
<td>ws-security.enableRevocation</td>
<td>false</td>
<td>Whether to enable Certificate Revocation List (CRL) checking or not when verifying trust in a certificate.</td>
</tr>
<tr>
<td>ws-security.username-token.always.encrypted</td>
<td>true</td>
<td>Whether to always encrypt UsernameTokens that are defined as a SupportingToken. This should not be set to false in a production environment, as it exposes the password (or the digest of the password) on the wire.</td>
</tr>
<tr>
<td>ws-security.is-bsp-compliant</td>
<td>true</td>
<td>Whether to enforce compliance with the Basic Security Profile (BSP) 1.1 or not.</td>
</tr>
<tr>
<td>ws-security.self-sign-saml-assertion</td>
<td>false</td>
<td>Whether to self-sign a SAML Assertion or not. If this is set to true, then an enveloped signature will be generated when the SAML Assertion is constructed.</td>
</tr>
<tr>
<td>ws-security.enable.nonce.cache</td>
<td>(varies)</td>
<td>Whether to cache UsernameToken nonces. See See the JavaDoc for more information.</td>
</tr>
<tr>
<td>ws-security.enable.timestamp.cache</td>
<td>(varies)</td>
<td>Whether to cache Timestamp Created Strings. See the JavaDoc for more information.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Constant</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ws-security.timestamp.timeToLive</td>
<td></td>
<td>The time in seconds to append to the Creation value of an incoming Timestamp to determine whether to accept the Timestamp as valid or not. The default value is 300 seconds (5 minutes).</td>
</tr>
<tr>
<td>ws-security.timestamp.futureTimeToLive</td>
<td></td>
<td>This configuration tag specifies the time in seconds in the future within which the Created time of an incoming Timestamp is valid. The default value is 60 seconds. See the JavaDoc for more information.</td>
</tr>
<tr>
<td>ws-security.saml-role-attributename</td>
<td></td>
<td>The attribute URI of the SAML AttributeStatement where the role information is stored. The default is “<a href="http://schemas.xmlsoap.org/ws/2005/05/identity/claims/role%E2%80%9D">http://schemas.xmlsoap.org/ws/2005/05/identity/claims/role”</a>.</td>
</tr>
<tr>
<td>ws-security.kerberos.client</td>
<td></td>
<td>A reference to the Kerberos client object class used to obtain a service ticket.</td>
</tr>
<tr>
<td>ws-security.spnego.client.action</td>
<td></td>
<td>The SpnegoClientAction implementation to use for SPNEGO. This allows the user to plug in a different implementation to obtain a service ticket.</td>
</tr>
<tr>
<td>ws-security.kerberos.jaas.context</td>
<td></td>
<td>The JAAS Context name to use for Kerberos. This is currently only supported for SPNEGO.</td>
</tr>
<tr>
<td>ws-security.kerberos.spn</td>
<td></td>
<td>The Kerberos Service Provider Name (spn) to use. This is currently only supported for SPNEGO.</td>
</tr>
<tr>
<td>ws-security.nonce.cache.instance</td>
<td></td>
<td>This holds a reference to a ReplayCache instance used to cache UsernameToken nonces. The default instance that is used is the EHCacheReplayCache.</td>
</tr>
<tr>
<td>ws-security.timestamp.cache.instance</td>
<td></td>
<td>This holds a reference to a ReplayCache instance used to cache Timestamp Created Strings. The default instance that is used is the EHCacheReplayCache.</td>
</tr>
<tr>
<td>ws-security.cache.config.file</td>
<td></td>
<td>Set this property to point to a configuration file for the underlying caching implementation. The default configuration file that is used is cxf-ehcache.xml in the cxf-rt-ws-security module.</td>
</tr>
</tbody>
</table>
The `TokenStore` instance to use to cache security tokens. By default this uses the `EHCacheTokenStore` if EhCache is available. Otherwise it uses the `MemoryTokenStore`.

A comma separated String of regular expressions which will be applied to the subject DN of the certificate used for signature validation, after trust verification of the certificate chain associated with the certificate. These constraints are not used when the certificate is contained in the keystore (direct trust).

**Table 2.5. Validator implementations for validating received security tokens**

<table>
<thead>
<tr>
<th>Tag</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ws-security.ut.validator</code></td>
<td>The WSS4J Validator instance to use to validate UsernameTokens. The default value is the <code>UsernameTokenValidator</code>.</td>
</tr>
<tr>
<td><code>ws-security.saml1.validator</code></td>
<td>The WSS4J Validator instance to use to validate SAML 1.1 Tokens. The default value is the <code>SamlAssertionValidator</code>.</td>
</tr>
<tr>
<td><code>ws-security.saml2.validator</code></td>
<td>The WSS4J Validator instance to use to validate SAML 2.0 Tokens. The default value is the <code>SamlAssertionValidator</code>.</td>
</tr>
<tr>
<td><code>ws-security.timestamp.validator</code></td>
<td>The WSS4J Validator instance to use to validate Timestamps. The default value is the <code>TimestampValidator</code>.</td>
</tr>
<tr>
<td><code>ws-security.signature.validator</code></td>
<td>The WSS4J Validator instance to use to validate trust in credentials used in Signature verification. The default value is the <code>SignatureTrustValidator</code>.</td>
</tr>
<tr>
<td><code>ws-security.bst.validator</code></td>
<td>The WSS4J Validator instance to use to validate BinarySecurityTokens. The default value is the <code>NoOpValidator</code>.</td>
</tr>
<tr>
<td><code>ws-security.sct.validator</code></td>
<td>The WSS4J Validator instance to use to validate SecurityContextTokens. The default value is the <code>NoOpValidator</code>.</td>
</tr>
</tbody>
</table>

**Table 2.6. STS Client Configuration tags**

<table>
<thead>
<tr>
<th>Tag</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ws-security.sts.client</code></td>
<td>A reference to the STSClient class used to communicate with the STS.</td>
</tr>
<tr>
<td><code>ws-security.sts.applies-to</code></td>
<td>The &quot;AppliesTo&quot; address to send to the STS. The default is the endpoint address of the service provider.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.usecert</code></td>
<td>If true, writes out an X509Certificate structure in UseKey/KeyInfo. If false (the default), writes out a KeyValue structure instead.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.do.cancel</code></td>
<td>Whether to cancel a token when using SecureConversation after successful invocation. The default is 'false'.</td>
</tr>
<tr>
<td><code>ws-security.cache.issued.token.in.endpoint</code></td>
<td>Set this to &quot;false&quot; to not cache a SecurityToken per proxy object in the IssuedTokenInterceptorProvider. This should be done if a token is being retrieved from an STS in an intermediary. The default value is &quot;true&quot;.</td>
</tr>
<tr>
<td><code>ws-security.sts.disable-wsmex-call-using-epr-address</code></td>
<td>Whether to avoid STS client trying send WS-MetadataExchange call using STS EPR WSA address when the endpoint contract contains no WS-MetadataExchange info. The default value is &quot;false&quot;.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.crypto</code></td>
<td>A Crypto object to be used for the STS. See the JavaDoc for more information.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.properties</code></td>
<td>The Crypto property configuration to use for the STS. See the JavaDoc for more information.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.username</code></td>
<td>The alias name in the keystore to get the user’s public key to send to the STS for the PublicKey KeyType case.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.act-as</code></td>
<td>The token to be sent to the STS in an 'ActAs' field. See the JavaDoc for more information.</td>
</tr>
<tr>
<td><code>ws-security.sts.token.on-behalf-of</code></td>
<td>The token to be sent to the STS in an &quot;OnBehalfOf&quot; field. See the JavaDoc for more information.</td>
</tr>
</tbody>
</table>

**Note:** for Symmetric bindings that specify a protection token, the `ws-security-encryption` properties are used.
Configuring via Spring

The properties are easily configured as client or endpoint properties--use the former for the SOAP client, the latter for the web service provider.

```
<beans xmlns="http://www.springframework.org/schema/beans"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:jaxws="http://cxf.apache.org/jaxws"
      xsi:schemaLocation="http://www.springframework.org/schema/beans
          http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
          http://cxf.apache.org/jaxws
          http://cxf.apache.org/schemas/jaxws.xsd">
  <jaxws:client name="{http://cxf.apache.org}MyPortName"
                createdFromAPI="true">
    <jaxws:properties>
      <entry key="ws-security.callback-handler"
             value="interop.client.KeystorePasswordCallback"/>
      <entry key="ws-security.signature.properties"
             value="etc/client.properties"/>
      <entry key="ws-security.encryption.properties"
             value="etc/service.properties"/>
      <entry key="ws-security.encryption.username"
             value="servicekeyalias"/>
    </jaxws:properties>
  </jaxws:client>
</beans>
```

For the jaxws:client's `name` attribute above, use the namespace of the WSDL along with the `name` attribute of the desired `wsdl:port` element under the WSDL's service section. (See here and here for an example.)

```
<beans xmlns="http://www.springframework.org/schema/beans"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:jaxws="http://cxf.apache.org/jaxws"
      xsi:schemaLocation="http://www.springframework.org/schema/beans
          http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
          http://cxf.apache.org/jaxws
          http://cxf.apache.org/schemas/jaxws.xsd">
  <jaxws:endpoint
    id="MyService"
    address="https://localhost:9001/MyService"
    serviceName="interop:MyService"
    endpointName="interop:MyServiceEndpoint"
    implementor="com.foo.MyService">
    <jaxws:properties>
      <entry key="ws-security.callback-handler"
             value="interop.client.UTPasswordCallback"/>
      <entry key="ws-security.signature.properties"
             value="etc/keystore.properties"/>
      <entry key="ws-security.encryption.properties"
             value="etc/truststore.properties"/>
      <entry key="ws-security.encryption.username"
             value="useReqSigCert"/>
    </jaxws:properties>
  </jaxws:endpoint>
</beans>
```
Configuring via API's

Configuring the properties for the client just involves setting the properties in the client's RequestContext:

```java
Map<String, Object> ctx = ((BindingProvider)port).getRequestContext();
ctx.put("ws-security.encryption.properties", properties);
port.echoString("hello");
```

2.6.8. WS-Trust

WS-Trust support in CXF builds upon the WS-SecurityPolicy implementation to handle the IssuedToken policy assertions that could be found in the WS-SecurityPolicy fragment.

**Note:** Because the WS-IssuedToken support builds on the WS-SecurityPolicy support, this is currently only available to "wsdl first" projects.

WS-Trust extends the WS-Security specification to allow issuing, renewing, and validation of security tokens. A lot of what WS-Trust does centers around the use of a "Security Token Service", or STS. The STS is contacted to obtain security tokens that are used to create messages to talk to the services. The primary use of the STS is to acquire SAML tokens used to talk to the service. Why is this interesting?

When using "straight" WS-Security, the client and server need to have keys exchanged in advance. If the client and server are both in the same security domain, that isn’t usually a problem, but for larger, complex applications spanning multiple domains, that can be a burden. Also, if multiple services require the same security credentials, updating all the services when those credentials change can by a major operation.

WS-Trust solves this by using security tokens that are obtained from a trusted Security Token Service. A client authenticates itself with the STS based on policies and requirements defined by the STS. The STS then provides a security token (example: a SAML token) that the client then uses to talk to the target service. The service can validate that token to make sure it really came from the trusted STS.

When the WS-SecurityPolicy runtime in CXF encounters an IssuedToken assertion in the policy, the runtime requires an instance of org.apache.cxf.ws.security.trust.STSClient to talk to the STS to obtain the required token. Since the STSClient is a WS-SecurityPolicy client, it will need configuration items to be able to create it's secure SOAP messages to talk to the STS.

2.6.8.1. General Configuration

There are several ways to configure the STSClient:

**Direct configuration of an STSClient bean in the properties:** In this scenario, a STSClient object is created directly as a property of the client object. The wsdlLocation, service/endpoint names, etc., are all configured in line for that client.

```xml
<jaxws:client name="{http://cxf.apache.org/}MyService"
```
The above example shows a configuration where the STS uses the UsernameToken profile to validate the client. It is assumed the keystore identified within clientKeystore.properties contains both the private key of the client and the public key (identified above as mystskey) of the STS; if not, create separate property files for the signature properties and the encryption properties, pointing to the keystore and truststore respectively.

Remember the jaxws:client createdFromAPI attribute needs to be set to true (as shown above) if you created the client programmatically via the CXF API's--i.e., Endpoint.publish() or Service.getPort().

This also works for "code first" cases as you can do:

```java
STSClient sts = new STSClient(...);
sts.setXXX(...);
.....
((BindingProvider)port).getRequestContext().
  put("ws-security.sts.client", sts);
```

Sample clientKeystore.properties format:

```ini
org.apache.ws.security.crypto.merlin.keystore.type=jks
org.apache.ws.security.crypto.merlin.keystore.password=KeystorePasswordHere
org.apache.ws.security.crypto.merlin.keystore.alias=ClientKeyAlias
org.apache.ws.security.crypto.merlin.keystore.file=NameOfKeystore.jks
```

**Indirect configuration based on endpoint name:** If the runtime does not find a STSClient bean configured directly on the client, it checks the configuration for a STSClient bean with the name of the endpoint appended with ".sts-client". For example, if the endpoint name for your client is 

```text
{http://cxf.apache.org/}TestEndpoint
```

then it can be configured as:
<bean name="{http://cxf.apache.org/}TestEndpoint.sts-client"
class="org.apache.cxf.ws.security.trust.STSClient" abstract="true">
    <property name="wsdlLocation" value="WSDL/wsdl/trust.wsdl"/>
    <property name="serviceName" value="{http://cxf.apache.org/securitytokenservice} ... SecurityTokenService"/>
    <property name="endpointName" value="{http://cxf.apache.org/securitytokenservice} ... SecurityTokenEndpoint"/>
    <property name="properties">
        <map>
            <entry key="ws-security.signature.properties" value="etc/alice.properties"/>
            <entry key="ws-security.encryption.properties" value="etc/bob.properties"/>
            <entry key="ws-security.encryption.username" value="stskeyname"/>
        </map>
    </property>
</bean>

This properties configured in this example demonstrate STS validation of the client using the X.509 token profile. The abstract="true" setting for the bean defers creation of the STSClient object until it is actually needed. When that occurs, the CXF runtime will instantiate a new STSClient using the values configured for this bean.

**Default configuration:** If an STSClient is not found from the above methods, it then tries to find one configured like the indirect, but with the name "default.sts-client". This can be used to configure sts-clients for multiple services.

### 2.6.8.2. WS-Trust 1.4 Support

CXF supports some of the new functionality defined in the WS-Trust 1.4 specification. The currently supported features are listed below.

**ActAs**

The ActAs capability allows an initiator to request a security token that allows it to act as if it were somebody else. This capability becomes important in composite services where intermediate services make additional requests on-behalf of the true initiator. In this scenario, the relying party (the final destination of an indirect service request) may require information about the true origin of the request. The ActAs capability allows an intermediary to request a token that can convey this information.

The content of the ActAs element to be sent in the STS RequestSecurityToken call can be set in one of two ways:

- By specifying a value for the JAX-WS property SecurityConstants.STS_TOKEN_ACT_AS ("ws-security.sts.token.act-as")
- By specifying a value for the STSClient.actAs property.
For either case, the value can be one of the following:

- A String
- A DOM Element
- A CallbackHandler object to use to obtain the token

For example, the following code fragment demonstrates how to use an interceptor to dynamically set the content of the ActAs element in the STS RST. Note that this interceptor is applied to the secured client, the initiator, and not to the STSClient’s interceptor chain.

```java
public class ActAsOutInterceptor extends AbstractPhaseInterceptor<Message> {
    ActAsOutInterceptor () {
        // This can be in any stage before the WS-SP interceptors
        // setup the STS client and issued token interceptor.
        super(Phase.SETUP);
    }  
    @Override
    public void handleMessage(Message message) throws Fault {
        message.put(SecurityConstants.STS_TOKEN_ACT_AS, ...);
    }
}
```

Alternatively, the ActAs content may be set directly on the STS as shown below.

```xml
<bean name="{http://cxf.apache.org/}TestEndpoint.sts-client"
     class="org.apache.cxf.ws.security.trust.STSClient" abstract="true">
    <property name="wsdlLocation" value="WSDL/wsdl/trust.wsdl"/>
    <property name="serviceName" value="{http://cxf.apache.org/securitytokenservice}SecurityTokenService"/>
    <property name="endpointName" value="{http://cxf.apache.org/securitytokenservice}SecurityTokenEndpoint"/>
    <property name="actAs" value="..."/>
    <property name="properties">
        <map>
            ...
            </map>
        </property>
</bean>
```

**OnBehalfOf**

The OnBehalfOf capability allows an initiator to request a security token on behalf of somebody else. The content of the OnBehalfOf element to be sent in the STS RequestSecurityToken call can be set in one of two ways:

- By specifying a value for the JAX-WS property SecurityConstants.STS_TOKEN_ON_BEHALF_OF ("ws-security.sts.token.on-behalf-of")
- By specifying a value for the STSClient.onBehalfOf property.

The allowed values are the same as above for the ActAs property.
2.7. CXF Customizations

2.7.1. Annotations

CXF provides several custom annotations that can be used to configure and customize the CXF runtime.

2.7.1.1. org.apache.cxf.feature.Features

The @Features annotation is used to add Features, something that is able to customize a Server, Client, or Bus, typically by adding capabilities. See the CXF Features List for those provided "out of the box" by CXF. You can also create your own features. In many cases, however, those features have Annotations themselves which can be used and provide greater control over configuration.

2.7.1.2. org.apache.cxf.interceptor.InInterceptors,
org.apache.cxf.interceptor.OutInterceptors,
org.apache.cxf.interceptor.OutFaultInterceptors,
org.apache.cxf.interceptor.InFaultInterceptors

Add interceptors to the various chains used to process messages.

2.7.1.3. org.apache.cxf.annotations.WSDLDocumentation
org.apache.cxf.annotations.WSDLDocumentationCollection (since 2.3)

For "java first" scenarios where the WSDL is derived from the Java interfaces/code, these annotations allow adding wsd:documentation elements to various locations in the generated wsdl.

For example:

```java
@WebService
@WSDLDocumentationCollection(
    { 
        @WSDLDocumentation("My portType documentation"),
        @WSDLDocumentation(value = "My top level documentation",
            placement = WSDLDocumentation.Placement.TOP),
        @WSDLDocumentation(value = "My binding doc",
            placement = WSDLDocumentation.Placement.BINDING)
    } 
)
```
public interface MyService {
    @WSDLDocumentation("The docs for echoString")
    String echoString(String s);
}

2.7.1.4. org.apache.cxf.annotations.SchemaValidation (since 2.3)

Turns on SchemaValidation for messages. By default, for performance reasons, CXF does not validate message against the schema. By turning on validation, problems with messages not matching the schema are easier to determine.

2.7.1.5. org.apache.cxf.annotations.DataBinding (since 2.2.4)

Sets the DataBinding class that is associated with the service. By default, CXF assumes you are using the JAXB data binding. However, CXF supports different databindings such as XMLBeans, Aegis, SDO, and possibly more. This annotation can be used in place of configuration to select the databinding class.

@DataBinding(org.apache.cxf.sdo.SDODataBinding.class)
public interface MyService {
    public commonj.sdo.DataObject echoStruct(
            commonj.sdo.DataObject struct
    );
}

2.7.1.6. org.apache.cxf.annotations.Logging (since 2.3)

Turns on logging for the endpoint. Can be used to control the size limits of what gets logged as well as the location. It supports the following attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>limit</td>
<td>Sets the size limit after which the message is truncated in the logs. Default is 64K</td>
</tr>
<tr>
<td>inLocation</td>
<td>Sets the location to log incoming messages. Can be &lt;stderr&gt;, &lt;stdout&gt;, &lt;logger&gt;, or a file: URL. Default is &lt;logger&gt;</td>
</tr>
<tr>
<td>outLocation</td>
<td>Sets the location to log outgoing messages. Can be &lt;stderr&gt;, &lt;stdout&gt;, &lt;logger&gt;, or a file: URL. Default is &lt;logger&gt;</td>
</tr>
</tbody>
</table>

@Logging(limit=16000, inLocation="<stdout>")
public interface MyService {
    String echoString(String s);
}
2.7.1.7. org.apache.cxf.annotations.GZIP (since 2.3)

Enables GZIP compression of on-the-wire data. Supported attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>threshold</td>
<td>the threshold under which messages are not gzipped</td>
</tr>
</tbody>
</table>

GZIP is a negotiated enhancement. An initial request from a client will not be gzipped, but an Accept header will be added and if the server supports it, the response will be gzipped and any subsequent requests will be.

2.7.1.8. org.apache.cxf.annotations.FastInfoset (since 2.3)

Enables FastInfoset of on-the-wire data. Supported attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>force</td>
<td>forces the use of fastinfoset instead of negotiating. Default is false</td>
</tr>
</tbody>
</table>

FastInfoset is a negotiated enhancement. An initial request from a client will not be in fastinfoset, but an Accept header will be added and if the server supports it, the response will be in fastinfoset and any subsequent requests will be.

2.7.1.9. org.apache.cxf.annotations.EndpointProperty

Add a property to an endpoint. Many things such as WS-Security related things and such can be configured via endpoint properties. Traditionally, these would be set via the <jaxws:properties> element on the <jaxws:endpoint> element in the spring config, but these annotations allow these properties to be configured into the code.

```java
@WebService
@EndpointProperties(
    {
        @EndpointProperty(key = "my.property", value="some value"),
        @EndpointProperty(key = "my.other.property",
            value="some other value")
    })
public interface MyService {
    String echoString(String s);
}
```

2.7.1.10. org.apache.cxf.annotations.Policy

Used to attach WS-Policy fragments to a service or operation. The Policy supports the attributes:
<table>
<thead>
<tr>
<th>uri</th>
<th>REQUIRED the location of the file containing the Policy definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>includeInWSDL</td>
<td>Whether to include the policy in the generated WSDL when generating a wsdl. Default it true</td>
</tr>
<tr>
<td>placement</td>
<td>Specify where to place the policy</td>
</tr>
<tr>
<td>faultClass</td>
<td>if placement is a FAULT, this specifies which fault the policy would apply to</td>
</tr>
</tbody>
</table>

When using a custom Spring configuration, you’ll need to import META-INF/cxf/cxf-extension-policy.xml

```java
@Policies({
    @Policy(uri = "annotationpols/TestInterfacePolicy.xml"),
    @Policy(uri = "annotationpols/TestImplPolicy.xml", placement = Policy.Placement.SERVICE_PORT),
    @Policy(uri = "annotationpols/TestPortTypePolicy.xml", placement = Policy.Placement.PORT_TYPE)
})
@WebService
public static interface TestInterface {
    @Policies({
        @Policy(uri = "annotationpols/TestOperationPolicy.xml"),
        @Policy(uri = "annotationpols/TestOperationInputPolicy.xml", placement = Policy.Placement.BINDING_OPERATION_INPUT),
        @Policy(uri = "annotationpols/TestOperationOutputPolicy.xml", placement = Policy.Placement.BINDING_OPERATION_OUTPUT),
        @Policy(uri = "annotationpols/TestOperationPTPolicy.xml", placement = Policy.Placement.PORT_TYPE_OPERATION),
        @Policy(uri = "annotationpols/TestOperationPTInputPolicy.xml", placement = Policy.Placement.PORT_TYPE_OPERATION_INPUT),
        @Policy(uri = "annotationpols/TestOperationPTOutputPolicy.xml", placement = Policy.Placement.PORT_TYPE_OPERATION_OUTPUT)
    })
    int echoInt(int i);
}
```

2.7.1.11. org.apache.cxf.annotations.UseAsyncMethod (since 2.6.0)

Used on the JAX-WS service implementation object to mark a method as preferring the ‘async’ version of the method instead of the synchronous version. With JAX-WS, services default to the synchronous methods that require the returning value to be returned from the method. By marking a method with the `@UseAsyncMethod` annotation, if the transport supports it, CXF will call the async version that takes an AsynHandler object and the service can call that handler when the response is ready. If the transport does not support the CXF continuations, the synchronous method will be called as normal.

2.7.2. Dynamic Clients

The usual way to construct a web service client is to include the Java interface for the service (the SEI) and any classes that are used for inputs and output in the client application. This is not always desirable or practical.
CXF supports several alternatives to allow an application to communicate with a service without the SEI and data classes. JAX-WS specified the Dispatch API, as well as the Provider interface for reading and writing XML. This page, however, describes the dynamic client facility of CXF. With dynamic clients, CXF generates SEI and bean classes at runtime, and allows you to invoke operations via APIs that take Objects, or by using reflection to call into full proxies.

Note that, in general, CXF only supports WSI-BP services. If you attempt to create a dynamic client for a WSDL that uses features outside of WSI-BP, CXF may throw an exception.

2.7.2.1. DynamicClientFactory and JaxWsDynamicClientFactory

CXF provides two factory classes for dynamic classes. If your service is defined in terms of JAX-WS concepts, you should use the JaxWsDynamicClientFactory. If you do not want or need JAX-WS semantics, use the DynamicClientFactory. The remainder of this page uses the JaxWs version.

Let's pretend for a moment that you have a WSDL which defines a single operation "echo" which takes an input of a string and outputs a String. You could use the JaxWsDynamicClientFactory for it like this:

```java
JaxWsDynamicClientFactory dcf = JaxWsDynamicClientFactory.newInstance();
Client client = dcf.createClient("echo.wsdl");
Object[] res = client.invoke("echo", "test echo");
System.out.println("Echo response: " + res[0]);
```

Many WSDLs will have more complex types though. In this case the JaxWsDynamicClientFactory takes care of generating Java classes for these types. For example, we may have a People service which keeps track of people in an organization. In the sample below we create a Person object that was generated for us dynamically and send it to the server using the addPerson operation:

```java
JaxWsDynamicClientFactory dcf = JaxWsDynamicClientFactory.newInstance();
Client client = dcf.createClient("people.wsdl", classLoader);
Object person = Thread.currentThread().getContextClassLoader().loadClass("com.acme.Person").newInstance();
Method m = person.getClass().getMethod("setName", String.class);
m.invoke(person, "Joe Schmoe");
client.invoke("addPerson", person);
```

You may be asking yourself the following question: "Where did the class name 'com.acme.Person' come from?"

One way to get the class names is to run wsdl2java and examine the results. The dynamic client factory uses the same code generator as that tool. Another way is to walk the CXF service model. This has the advantage that it delivers Class<?> objects directly, so you don’t need to obtain the correct class loader reference and run loadClass.

The wsdl_first_dynamic_client sample uses this approach. Read the file 'ComplexClient.java' to see the process, which uses some of the java.bean classes to simplify the code slightly.
The JaxWsDynamicClientFactory sets the Thread context ClassLoader to a new ClassLoader that contains the classes for the generated types. If you need the original ClassLoader, make sure you save it prior to calling createClient.

## 2.8. CXF Command-Line Tools

The most up-to-date instructions for building SOAP web-services are maintained in the CXF User’s Guide. In particular, see the `wsdl2java` utility for contract-first development and `java2ws` tool for the start-from-Java approach. For Maven-based projects, CXF offers plugins for both WSDL-first (`cxf-codegen-plugin`) and Java-first (`cxf-java2ws-plugin`) development.

### 2.8.1. WSDL to Java

`wsdl2java` creates JAX-WS and JAXB (or other databinding framework) objects from a service WSDL. It has the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-h</code></td>
<td>Displays the online help for this utility and exits.</td>
</tr>
<tr>
<td><code>-fe frontend-name</code></td>
<td>Specifies the frontend. Default is JAXWS. Currently supports only JAXWS frontend and a &quot;jaxws21&quot; frontend to generate JAX-WS 2.1 compliant code.</td>
</tr>
<tr>
<td><code>-db databinding-name</code></td>
<td>Specifies the databinding. Default is jaxb. Currently supports jaxb, xmlbeans, sdo (sdo-static and sdo-dynamic), and jibx.</td>
</tr>
<tr>
<td><code>-wv wsdl-version</code></td>
<td>Specifies the wsdl version. Default is WSDL1.1. Currently supports only WSDL1.1 version.</td>
</tr>
<tr>
<td><code>-p [ wsdl-namespace= ] PackageName</code></td>
<td>Specifies zero, or more, package names to use for the generated code. Optionally specifies the WSDL namespace to package name mapping.</td>
</tr>
<tr>
<td><code>-sn service-name</code></td>
<td>The WSDL service name to use for the generated code.</td>
</tr>
<tr>
<td><code>-b binding-name</code></td>
<td>Specifies JAXWS or JAXB binding files or XMLBeans context files. Use multiple <code>-b</code> flags to specify multiple entries.</td>
</tr>
<tr>
<td><code>-catalog catalog-file-name</code></td>
<td>Specify catalog file to map the imported wsdl/schema</td>
</tr>
<tr>
<td><code>-d output-directory</code></td>
<td>Specifies the directory into which the generated code files are written.</td>
</tr>
<tr>
<td><code>-compile</code></td>
<td>Compiles generated Java files.</td>
</tr>
<tr>
<td><code>-classdir compile-class-dir</code></td>
<td>Specifies the directory into which the compiled class files are written.</td>
</tr>
<tr>
<td><code>-client</code></td>
<td>Generates starting point code for a client mainline.</td>
</tr>
<tr>
<td><code>-clientjar jar-file-name</code></td>
<td>Generates the jar file which contains all the client classes and wsdls; wsdllocation param ignored with this setting.</td>
</tr>
<tr>
<td><code>-server</code></td>
<td>Generates starting point code for a server mainline.</td>
</tr>
<tr>
<td><code>-impl</code></td>
<td>Generates starting point code for an implementation object.</td>
</tr>
<tr>
<td><code>-all</code></td>
<td>Generates all starting point code: types, service proxy, service interface, server mainline, client mainline, implementation object, and an Ant build.xml file.</td>
</tr>
<tr>
<td><code>-ant</code></td>
<td>Specify to generate an Ant build.xml script.</td>
</tr>
<tr>
<td><code>-autoNameResolution</code></td>
<td>Automatically resolve naming conflicts without requiring the use of binding customizations.</td>
</tr>
<tr>
<td><code>-defaultValues= [DefaultValueProvider impl ]</code></td>
<td>Specifies that default values are generated for the impl and client. You can also provide a custom default value provider. The default provider is RandomValueProvider</td>
</tr>
<tr>
<td>Parameter</td>
<td>Option</td>
</tr>
<tr>
<td>-----------</td>
<td>--------</td>
</tr>
<tr>
<td>-nexclude schema-namespace [=java-packagename ]</td>
<td>Ignore the specified WSDL schema namespace when generating code. This option may be specified multiple times. Also, optionally specifies the Java package name used by types described in the excluded namespace(s).</td>
</tr>
<tr>
<td>-exh (true/false)</td>
<td>Enables or disables processing of implicit SOAP headers (i.e. SOAP headers defined in the wsdl:binding but not wsdl:portType section.) Default is false.</td>
</tr>
<tr>
<td>-dns (true/false)</td>
<td>Enables or disables the loading of the default namespace package name mapping. Default is true and [<a href="http://www.w3.org/2005/08/addressing=org.apache.cxf.ws.addressing">http://www.w3.org/2005/08/addressing=org.apache.cxf.ws.addressing</a>] namespace package mapping will be enabled.</td>
</tr>
<tr>
<td>-dex (true/false)</td>
<td>Enables or disables the loading of the default excludes namespace mapping. Default is true.</td>
</tr>
<tr>
<td>-validate</td>
<td>Enables validating the WSDL before generating the code.</td>
</tr>
<tr>
<td>-keep</td>
<td>Specifies that the code generator will not overwrite any preexisting files. You will be responsible for resolving any resulting compilation issues.</td>
</tr>
<tr>
<td>-wsdlLocation wsdlLocation</td>
<td>Specifies the value of the @WebServiceClient annotation’s wsdlLocation property.</td>
</tr>
<tr>
<td>-xjc&lt;xjc args&gt;</td>
<td>Specifies a comma separated list of [arguments]<a href="https://jaxb.dev.java.net/nonav/2.2/docs/xjc.html">https://jaxb.dev.java.net/nonav/2.2/docs/xjc.html</a>] that are passed directly to the XJC processor when using the JAXB databinding. A list of available XJC plugins can be obtained using -xjc -X.</td>
</tr>
<tr>
<td>-noAddressBinding</td>
<td>For compatibility with CXF 2.0, this flag directs the code generator to generate the older CXF proprietary WS-Addressing types instead of the JAX-WS 2.1 compliant WS-Addressing types.</td>
</tr>
<tr>
<td>-v</td>
<td>Displays the version number for the tool.</td>
</tr>
<tr>
<td>-verbose</td>
<td>Displays comments during the code generation process.</td>
</tr>
<tr>
<td>-quiet</td>
<td>Suppresses comments during the code generation process.</td>
</tr>
<tr>
<td>-exceptionSuper superclass for any fault beans generated from wsdl:fault elements (defaults to java.lang.Exception)</td>
<td></td>
</tr>
<tr>
<td>-reserveClass classname</td>
<td>Used with -autoNameResolution, defines a class names for wsdl-to-java not to use when generating classes. Use this option multiple times for multiple classes.</td>
</tr>
<tr>
<td>-allowElementReferences</td>
<td>If true, disregards the rule given in section 2.3.1.2(v) of the JAX-WS 2.2 specification disallowing element references when using wrapper-style mapping.</td>
</tr>
<tr>
<td>-asyncMethods=foo,bar,...</td>
<td>List of subsequently generated Java class methods to allow for client-side asynchronous calls, similar to enableAsyncMapping in a JAX-WS binding file.</td>
</tr>
<tr>
<td>-bareMethods=foo,bar,...</td>
<td>List of subsequently generated Java class methods to have wrapper style (see below), similar to enableWrapperStyle in JAX-WS binding file.</td>
</tr>
<tr>
<td>-mimeMethods=foo,bar,...</td>
<td>List of subsequently generated Java class methods to enable mime:content mapping, similar to enableMIMEContent in JAX-WS binding file.</td>
</tr>
<tr>
<td>-faultSerialVersionUID &lt;fault-serialVersionUID&gt;</td>
<td>How to generate suid of fault exceptions. Use NONE, TIMESTAMP, FQCN, or a specific number. Default is NONE.</td>
</tr>
<tr>
<td><em>wsdlurl</em></td>
<td>The path and name of the WSDL file to use in generating the code.</td>
</tr>
</tbody>
</table>

Examples of wsdl2java in use:

* `wsdl2java HelloWorld.wsdl`
* `wsdl2java -p com.mycompany.greeting Greeting.wsdl`
* `wsdl2java -client HelloWorld.wsdl`
2.8.2. Java to WS

2.8.2.1. Name

java2ws - uses a Web service endpoint’s implementation (SEI) class and associated types classes to generate a WSDL file, wrapper bean, server side code to start the web service and client side code.

2.8.2.2. Synopsis

```bash
java2ws -databinding <jaxb or aegis> -frontend <jaxws or simple>
    -wsdl -wrapperbean -client -server -ant -o <output-file>
    -d <resource-directory> -classdir <compile-classes-directory>
    -cp <class-path> -soap12 -t <target-namespace>
    -beans <pathname of the bean definition file>*
    -address <port-address> -servicename <service-name>
    -portname <port-name> -createxsdimports -h -v -verbose
    -quiet {classname}
```

2.8.2.3. Description

java2ws uses a Web service endpoint’s implementation (SEI) class and associated types classes to generate a WSDL file, wrapper bean, server side code to start the web service and client side code.

2.8.2.4. Options

The options used to manage the code generation process are reviewed in the following table.

<table>
<thead>
<tr>
<th>Option</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-?,-h,-help</code></td>
<td>Displays the online help for this utility and exits.</td>
</tr>
<tr>
<td><code>-o</code></td>
<td>Specifies the name of the generated WSDL file.</td>
</tr>
<tr>
<td><code>-databinding</code></td>
<td>Specify the data binding (aegis or jaxb). Default is jaxb for jaxws frontend, and aegis for simple frontend.</td>
</tr>
<tr>
<td><code>-frontend</code></td>
<td>Specify the frontend to use. jaxws and the simple frontend are supported.</td>
</tr>
<tr>
<td><code>-wsdl</code></td>
<td>Specify to generate the WSDL file.</td>
</tr>
<tr>
<td><code>-wrapperbean</code></td>
<td>Specify to generate the wrapper and fault bean</td>
</tr>
<tr>
<td><code>-client</code></td>
<td>Specify to generate client side code</td>
</tr>
<tr>
<td><code>-server</code></td>
<td>Specify to generate server side code</td>
</tr>
<tr>
<td><code>-ant</code></td>
<td>Specify to generate an Ant build.xml script</td>
</tr>
<tr>
<td><code>-cp</code></td>
<td>Specify the SEI and types class search path of directories and zip/jar files.</td>
</tr>
<tr>
<td><code>-soap12</code></td>
<td>Specifies that the generated WSDL is to include a SOAP 1.2 binding.</td>
</tr>
</tbody>
</table>
### Option Interpretation

<table>
<thead>
<tr>
<th>Option</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>-t</td>
<td>Specifies the target namespace to use in the generated WSDL file.</td>
</tr>
<tr>
<td>-servicename</td>
<td>Specifies the value of the generated service element's name attribute.</td>
</tr>
<tr>
<td>-v</td>
<td>Displays the version number for the tool.</td>
</tr>
<tr>
<td>-verbose</td>
<td>Displays comments during the code generation process.</td>
</tr>
<tr>
<td>-quiet</td>
<td>Suppresses comments during the code generation process.</td>
</tr>
<tr>
<td>-s</td>
<td>The directory in which the generated source files (wrapper bean, fault bean, client side or server side code) are placed.</td>
</tr>
<tr>
<td>-classdir</td>
<td>The directory in which the generated sources are compiled into. If not specified, the files are not compiled.</td>
</tr>
<tr>
<td>-portname</td>
<td>Specify the port name to use in the generated wsdl.</td>
</tr>
<tr>
<td>-address</td>
<td>Specify the port address.</td>
</tr>
<tr>
<td>-beans</td>
<td>Specify the pathname of a file defining additional Spring beans to customize databinding configuration.</td>
</tr>
<tr>
<td>-creatsxdsimports</td>
<td>Output schemas to separate files and use imports to load them instead of inlining them into the wsdl.</td>
</tr>
<tr>
<td>-d</td>
<td>The directory in which the resource files are placed, wsdl file will be placed into this directory by default</td>
</tr>
<tr>
<td>classname</td>
<td>Specifies the name of the SEI class.</td>
</tr>
</tbody>
</table>

You must include the **classname** argument. All other arguments are optional and may be listed in any order. This tool will search and load the service endpoint class and types classes. Make certain these classes are on the **CLASSPATH** or in a location identified through the **-cp** flag. If none of “-wsdl, - wrapperbean, -client, -server” flags are specified, java2ws will generate nothing.

#### 2.8.2.5. Examples

```bash
java2ws -wsdl -d ./resource org.apache.hello.Greeter
java2ws -cp ./tmp org.apache.hello.Greeter -wsdl
java2ws -o hello.wsdl -wsdl org.apache.hello.Greeter
java2ws -client -server -s ./src org.apache.hello.Greeter
java2ws -wrapperbean -classdir ./classes org.apache.hello.Greeter
```

#### 2.9. JAX-WS Development With Eclipse

Development using the Eclipse IDE is another option. The Java Enterprise Edition version of Eclipse allows for rapid development, testing, and debugging, making it a compelling environment for web service development. Steps to follow for building web services with Eclipse:

1. **Download and attach Tomcat to Eclipse.**

   Tomcat needs to be linked into the IDE so Eclipse can start and stop the servlet container as well as deploy web services to it. (See the Eclipse/Tomcat FAQ to learn more.) Download and extract the Tomcat binary into its own directory if you haven’t already. Next, from
the Eclipse Preferences window (Menu item Windows->Preferences), select the Server -> Runtime Environments section and add your Tomcat installation to the IDE:

Ensure that the JRE being used is an actual Java Development Kit (JDK), which Tomcat needs in order to compile JSPs and potentially other source files.

2. Download and attach CXF to Eclipse.

Similar to Tomcat, download the latest release version of Apache CXF and expand into a directory on your computer. Next, from Eclipse Preferences, open up the Web Services -> CXF 2.x Preferences section and enter the CXF directory as shown below.

Also, in the Web Services -> Server and Runtime category, make sure the Server and Web Service Runtimes are set to your version of Tomcat and CXF respectively.
3. **Create a dynamic web project.**

We will next create a Eclipse dynamic web project to contain the web service provider and client. From the Eclipse File menu, Select New -> Dynamic Web Project (or New -> Other, and from the subsequent popup dialog Web -> Dynamic Web Project). Give the project any desired name ("WebServiceSample" is used below), make sure the proper Tomcat server is selected, and then press the Finish button as illustrated:

![Image of Eclipse Dynamic Web Project creation](image)

4. **Create the web service provider.**

We'll start from a WSDL-first approach.

a. First we'll create the WSDL. From the Eclipse Project Explorer, right-click WebServiceSample, select New -> File, and enter DoubleIt.wsdl as the file name. Next, copy-and-paste the DoubleIt.wsdl from the CXF repository into this new file.

b. Right-click WebServiceSample again and select New -> Other, and Web Services -> Web Service from the New dialog. Choose the Top Down (i.e., WSDL-first) web service approach and the DoubleIt.wsdl file you just created as the Service definition. Make sure the server and web service runtime (i.e., CXF) are correct. On the server thumbwheel, select the highest setting ("Test Service") as shown below.
Click finish. Eclipse will deploy the web service on Tomcat and provide a Web Services Explorer test window where you can enter numbers and see the doubled result, as shown below. However, the web service presently will just return a hardcoded number, we’ll need to modify the web service provider to return the desired result, which we’ll do next.
c. From the Project Explorer, under WebServiceSample, open up Java Resources: src and open the DoubleItPortTypeImpl.java file. Change the business logic of the doubleIt method to return twice the input parameter (i.e., `int _return = numberToDouble * 2;`) and save the file. Once saved, Eclipse automatically recompiles the class and redeploy it to the Tomcat server. You can return to the Web Services Explorer test window, enter a number and now see the properly doubled result.

5. **Create the web service client.**

We'll now use Eclipse to create a Java-based web service client. Right-click WebServiceSample from the Project Explorer and select New -> Other, and from the New dialog Web Services -> Web Service Client. From the window that appears enter the WSDL file and raise the thumbwheel all the way up to "test", as shown below. Then select "Next" and enter another package name for the client (say "org.example.doubleit.client") so it does not conflict with the web service provider package. Click Finish.
Two modifications to the autogenerated client code will need to be made. First, in the org.example.doubleit.client.DoubleItService file, the wsdlLocation and url fields highlighted below will need to be updated to the actual endpoint URL Eclipse is using for the web service provider. You can find the value by looking at the wsdlLocation field in the DoubleItService class of the web service provider (it’s also viewable in the Web Services Explorer test view).

```java
@WebServiceClient(name = "DoubleItService",
    wsdlLocation = "http://localhost:8080/WebServiceSample/
        + services/DoubleItPort?wsdl",
    targetNamespace = "http://www.example.org/DoubleIt")
public class DoubleItService extends Service {

    public final static URL WSDL_LOCATION;
    public final static QName SERVICE =
        new QName("http://www.example.org/DoubleIt",
            "DoubleItService");
    public final static QName DoubleItPort =
        new QName("http://www.example.org/DoubleIt",
            "DoubleItPort");

    static {
        URL url = null;
        try {
            url = new URL(
                    "http://localhost:8080/WebServiceSample/
                        + services/DoubleItPort?wsdl");
        } catch (MalformedURLException e) {
```
Second, in the DoubleItPortType_DoubleItPort_Client class modify the value of the
_doubleIt_numberToDouble constant to a number you wish to double (say “55”) and then
save your change. Then right-click the file in the Eclipse editor and select Run As -> Java
Application. You should see the result of the web service call (110) in the Eclipse Console
window:

```
INFO: Creating Service {http://www.example.org/DoubleIt}DoubleItService
from WSDL: http://localhost:8080/WebServiceSample/services/DoubleItPort?wsdl
Invoking doubleIt...
doubleIt.result=110
```

## 2.10. Talend ESB Policies

Talend offers custom policies that can be used within the Talend ESB, for example: the Correlation
ID policy, the WSDL Schema Validation policy, the Custom Schema Validation policy, the
Transformation policy, and the Compression policy.

However, those policies are only available in the Talend Enterprise and Talend Platform products.
They can be find under the `add-ons\registry\policies` directory of the Talend ESB delivery, and
can be uploaded to the Service Registry via the Talend Administration Center Web User Interface
(for more information, see the Talend Administration Center User Guide), or via Service Registry
commands (for more information, see the *Talend ESB Infrastructure Services Configuration Guide*).

Those policies can also be enabled by declaring the corresponding feature. For more information
on how to enable some of them via feature, see the following sections.

### 2.10.1. Correlation ID Policy

The correlation ID feature provides support for setting a business correlation ID. A correlation
ID can be set using:

- *Custom callback handler*,
- *Automated correlation ID generation (system UID)*.

#### 2.10.1.1. Maven project dependency

To use the Correlation ID policy in your project, you have to implement the following dependency:
2.10.1.2. Custom callback handler

The custom callback handler can be enabled via feature (supports both Soap and REST service):

```xml
<jaxrs:features>
  <bean
      class="org.talend.esb.policy.correlation.feature.CorrelationIDFeature"/>
</jaxrs:features>

<jaxws:properties>
  <entry key="correlation-id.callback-handler">
    <bean class="com.example.CorrelationHandler"/>
  </entry>
</jaxws:properties>
```

The bean class `com.example.CorrelationHandler` is a custom class which implements the `org.talend.esb.policy.correlation.CorrelationIDCallbackHandler` interface. If such callback class is not specified in the properties, then the correlation Id will be generated automatically by a default callback handler which provides a system UID. For more information, see Automated correlation ID generation (system UID).

It is also necessary to specify the correlation id handler:

```xml
<jaxws:properties>
  <entry key="correlation-id.callback-handler">
    <bean class="com.example.CorrelationHandler"/>
  </entry>
</jaxws:properties>
```

2.10.1.3. Automated correlation ID generation (system UID)

If you do not specify a callback handler and set `type="callback"` (or entirely omit the type attribute), then the id will be generated automatically as system UID, and the value will be the same for request and response:

Enabling via feature:

```xml
<jaxrs:features>
  <bean
      class="org.talend.esb.policy.correlation.feature.CorrelationIDFeature"/>
</jaxrs:features>
```

2.10.2. Transformation Policy

The Transformation policy allows to apply XSLT transformation to message payloads. The implementation is based on CXF interceptors.
2.10.2.1. Transformation configuration via Spring

To add the transformation feature to the endpoint, the transformation feature could be used:

Spring configuration

```xml
<bean id="xsltFeature" class="org.talend.esb.policy.transformation.feature.TransformationFeature">
    <property name="path" value="etc/requestTransformation.xsl"/>
    <property name="appliesTo" value="provider"/>
    <property name="message" value="request"/>
    <property name="type" value="xslt"/>
</bean>

<jaxws:client id="libraryHttp" serviceName="library:LibraryProvider"
    endpointName="library:LibraryHttpPort"
    address="http://localhost:8080/tesb-library-tutorial/services/LibraryHttpPort"
    serviceClass="org.talend.services.demos.library._1_0.Library">
    <jaxws:features>
        <ref bean="xsltFeature"/>
    </jaxws:features>
</jaxws:client>
```

2.10.2.2. Dependencies

When running a participant in servlet-container or as a standalone application, the following dependency should be used in the participant's pom.xml file:

**pom.xml for servlet-based or standalone participants**

```xml
<dependency>
    <groupId>org.talend.esb.policies</groupId>
    <artifactId>transformation-policy</artifactId>
    <version>${project.version}</version>
</dependency>
```

When running a participant in the Talend Runtime container, in the Require-Bundle section of Felix bundle plugin, the transformation-policy bundle should be mentioned:

**OSGi environment pom.xml**

```xml
<plugin>
    <groupId>org.apache.felix</groupId>
    <artifactId>maven-bundle-plugin</artifactId>
    <configuration>
        <instructions>
            <Bundle-SymbolicName>${project.artifactId}</Bundle-SymbolicName>
            <Require-Bundle>
                transformation-policy
            </Require-Bundle>
        </instructions>
    </configuration>
</plugin>
```
2.10.3. Compression policy

This section shows you how to use the Compression Feature in Talend ESB.

The compression feature of Talend ESB inherits the CXF GZIPOutInterceptor and enables GZIP compression of on-the-wire data. However, note that using Talend ESB Compression and CXF GZIP Compression together is not recommended.

The Talend ESB Compression feature is driven completely by the threshold attribute. So, the supported attribute is threshold - the value, in bytes, under which messages are not compressed. And its default value is "1024".

The Compression policy can be enabled via policy or by adding the feature, depending on the type of service (SOAP or REST).

**Enabling via feature** (support both Soap and REST service)

You can add the Compression feature to the features list:

```xml
<jaxws:features>
  <bean id="compressionFeature"
    class="org.talend.esb.policy.compression.feature.CompressionFeature">
    <property name="threshold" value="100"/>
  </bean>
</jaxws:features>
```
Chapter 3. JAX-RS Development

CXF supports the Java API for RESTful Web Services: parts of JAX-RS 2.0 (JSR-339) and fully JAX-RS 1.1 (JSR-311). CXF 2.7.0 supports most of the new features introduced in JAX-RS 2.0, excluding the client API, but note that the CXF client API has been retrofitted to support new filters, interceptors, exception classes and Response API, plus the asynchronous client invoker API.

You are encouraged to read the JAX-RS specification to find out information not covered by this documentation. The specification introduces such terms as root resources, resource methods, sub-resources and sub-resource locators, message body readers and writers, and contexts. Also check the CXF JAX-RS documentation for an up-to-date guide on new features and improvements. This section provides an overview of the JAX-RS specification and API.
3.1. Root Resources and Sub Resources

The Java class annotated with the @Path annotation represents a root resource class. The JAX-RS application may have more than one root resource class. Each root resource has one or more resource methods handling requests directly or delegating to subresources. Delegating resource methods are called subresource locators. Subresources are like root resource classes in that they can handle the request or delegate further with the exception being that their class-level @Path annotation is ignored during the method resolution. Effectively, the root resource class is a top level handler supporting a specific URI space of the RESTful web application. The default lifecycle of the root resource is per-request, that is, a new instance is created during every request. There is a number of options available to turn a root resource into the singleton.

Here is a sample JAX-RS root resource class:

```java
package demo.jaxrs.server;

import javax.ws.rs.GET;
import javax.ws.rs.Path;
import javax.ws.rs.PathParam;
import javax.ws.rs.Produces;
import javax.ws.rs.core.Context;
import javax.ws.rs.core.Response;
import javax.ws.rs.core.UriInfo;
import javax.ws.rs.core.UriBuilder;

@Path("/customerservice/")
@Produces("application/xml")
public class CustomerService {

    @Context
    private UriInfo uriInfo;

    @GET
    public Customers getCustomers() {
        return findAllCustomers();
    }

    @GET
    @Path("/{id}")
    @Produces({"application/json", "application/json"})
    public Customer getCustomer(@PathParam("id") long id) {
        return findCustomer(id);
    }

    @PUT
    @Path("/{id}")
    @Consumes("application/xml")
    public Response updateCustomer(@PathParam("id") Long id, Order order) {
        // update customer
        return Response.ok().build();
    }

    @POST
    public Response addCustomer(Customer customer) {
        // Create a new Customer resource and return a Location URI
        // pointing to it
        // Get the URIBuilder initialized with the base URI. For example,
        // if the servlet is listening on http://localhost:8080/webapp
        // then the builder will be set to this base URI
```
UriBuilder builder = uriInfo.getAbsolutePathBuilder();

    // Append the path value which this root resource class uses and
    // the id of the new customer
    // The newCustomerURI will represent a link to the new customer
    // resource.
    URI newCustomerURI = builder.path(CustomerService.class).path(
        customer.getId()).build();

    return Response.status(201).location(newCustomerURI).build();
}

@DELETE
@Path("/{id}")
public void deleteCustomer(@PathParam("id") String id) {
    // delete the customer
}

@Path("/{id}/orders/{orderId}/")
public Order getOrder(@PathParam("id") long customerId,
    @PathParam("orderId") long orderId) {
    return findCustomer(customerId).getOrder(orderId);
}

private Customers findAllCustomers() {
    // find all the customers
}

private Customer findCustomer(long id) {
    // find the customer with the given id
}

Customer resource class can handle requests with URI containing "/customerservice" path segments. For example, requests with the http://localhost/8080/webapp/customerservice URI and the GET HTTP verb will be handled by the getCustomers() method while requests with the "http://localhost/8080/webapp/customerservice/123" will be handled by one of the methods containing the @Path("{id}") annotation, depending on the HTTP verb such as GET, PUT or DELETE being used.

The getOrder() method is a subresource locator because it has no HTTP verb annotation, only the @Path annotation. The root resource may act as a sub-resource if one of its subresource locators delegates to it. For example, requests with the "http://localhost/8080/webapp/customerservice/123/orders/356/state" URI and the GET HTTP verb will be handled by the Order subresource instance. After the subresource locator getOrder() has returned, the runtime will use the remaining unmatched '/state' path segment to find the matching Order method.

### 3.2. Path, HTTP Method and MediaType annotations

The @Path annotation is applied to root resource classes or methods. The @Path value is a relative URI with one or more path segments. The value may be literal, for example, "customers/1/orders" or parameterized and contain one or more URITemplate variables: "customers/{id}/orders/"
{orderid}". In the latter example the "id" and "orderid" are template variables. The actual values will be available to resource methods with the help of @PathParam annotations. Template variables may also contain explicit regular expressions, for example: "/{id:.*}/" where "id" is the name of the variable and the expression after the semicolon is a custom regular expression.

When @Path is not available on the resource method then it is assumed to be equal to "/".

When selecting the root resource class, the runtime will try to match the relative request path available to it after the HTTP servlet matched the absolute request URI with the @Path value of the root resource. If the current root resource is not matched then the next root resource, if available, will be tried. After the successful match, the resource method will be selected given the remaining relative path and the HTTP method

Every resource method which is not a subresource locator must have an annotation indicating which HTTP verb is supported by this method. JAX-RS provides @GET, @DELETE, @POST, @PUT, @HEAD and @OPTIONS. Annotations for supporting other HTTP verbs can be created. The current resource method may only be selected if the value of its HTTP Method annotation is equal to the request HTTP verb.

The @Consumes annotation is used to specify the acceptable format of the request message. If it is not available on the resource method then it is inherited from a class, and if it’s not available on the class then it’s indirectly inherited from a corresponding JAX-RS MessageBodyReader, if any. The default value is "/" but it is recommended that a concrete media type is specified.

When attempting to select a given resource method, the runtime will try to match the value of the Content-Type HTTP header with the @Consumes value. If the match is successful then it will try to find the JAX-RS MessageBodyReader which can read the request message and convert it into the method parameter representing a request body. When looking for the reader, the runtime will also try to match the @Consumes value of the current reader with the request media type.

The @Produces annotation is used to specify the format of the response. If it is not available on the resource method then it is inherited from a class, and if it’s not available on the class then it’s indirectly inherited from a corresponding JAX-RS MessageBodyWriter, if any. The initial default value is "/" which will set to "application/octet-stream" before writing the actual response, thus it is recommended that a concrete media type is specified. For example, getCustomers() method inherits @Produces annotation from its class, while getCustomer() method overrides it with its own value.

When attempting to select a given resource method, the runtime will try to match the value of the Accept HTTP header with the @Produces value. The Accept and @Produces values may list multiple media types - the most preferred media type is chosen during the intersection. Additionally, when the resource method returns an object, the runtime will try to find the suitable JAX-RS MessageBodyWriter. When looking for the writer, the runtime will also try to match the @Produces value of the current writer with the media type obtained during the earlier intersection.

3.3. Request Message, Parameters and Contexts

Usually, the resource method has one or more parameters representing a request message body, HTTP headers and different parts of the request URI. The resource method may only have
one parameter representing a message body (and none in case of empty requests) but may have many parameters representing the headers or URI parts. @PathParam, @MatrixParam and @QueryParam capture various URI-related values while @HeaderParam and @Cookie capture various HTTP header values. @FormParam or JAX-RS MultivaluedMap can be used to capture name and value pairs of the form sequences.

The method parameter which has no JAX-RS annotations such as @PathParam does represent a request message. JAX-RS MessageBodyReader providers are responsible for reading the input stream and converting the data into this parameter object. JAXB-annotated, JAXP Source, InputStream and some other types are supported out of the box.

Method parameters representing URI parts or HTTP headers are the ones which have annotations such as @PathParam. These parameters are not handled by MessageBodyReader providers. The JAX-RS specification has the conversion rules which instruct the runtime to check the constructors or factory methods accepting Strings.

JAX-RS also introduces Contexts. Contexts represent the state of the request. UriInfo, HttpHeaders, SecurityContext, Request, HttpServletRequest, etc are contexts which can be injected into the fields of the JAX-RS root resource instance or passed in as method parameters annotated with the @Context annotation. Contexts such as UriInfo, HttpHeaders and Request make it easy to introspect and use the information contained in the current request URI and headers while SecurityContext can be used to check if the current user is in the provided role. Injecting contexts in the fields is usually recommended as it may help simplify the method signatures, for example, given that the query values can be found from the UriInfo context adding explicit @QueryParam parameters to method signatures may not be needed. The runtime will ensure that the contexts injected into the fields of the singleton root resource are thread-safe. For example, here is how a resource method may look like before the introduction of contexts:

```java
@Path("/")
public class BookResource {

    /**
     * Find the books with the id greater or equal to the passed id
     * and the authors first name equal to the passed name
     */
    @GET
    public Response findBook(@QueryParam("id") Long id,
        @QueryParam("name") String name) {
        // find the books
    }
}
```

In the above example, a method contains 2 query parameters. The alternative approach is to introduce a UriInfo context:

```java
@Path("/")
public class BookResource {
    @Context
    private UriInfo context;

    /**
     * Find the books as requested by the user query
     */
    @GET
    public Response findBook() {
        MultivaluedMap<String, String> map = context.getQueryParameters();
        // iterate over the map, check all the query parameters,
        // find the books
    }
}
```
3.4. Responses from Resource Methods

The resource method may return a custom Java class, JAX-RS Response or void. JAX-RS MessageBodyWriter providers are responsible for writing the custom Java class instance to the output stream. The runtime will set the HTTP 200 status.

Returning JAX-RS Response is useful when no response message is available, the HTTP status code needs to be customized or some response HTTP headers set. Returning "void" will result in the HTTP 204 (No Content) status being returned to the client.

3.5. Exception Handling

JAX-RS resource methods and indeed the runtime may throw all kind of exceptions. JAX-RS WebApplicationException can be used to report an error from the application code or the custom JAX-RS providers. WebApplicationException can have the HTTP status, headers and error message included.

When the application code or provider throws the runtime or checked exception, what happens by default is that the uncaught exception is propagated up to the HTTP container level so that the existing exception-handling code in Servlet filters, if any, can deal with the exception. A JAX-RS ExceptionMapper implementation can be used instead to capture the exception and convert it into an appropriate HTTP response. For example, the following mapper catches a Spring Security exception and converts it into the HTTP 403 status:

```java
package demo.jaxrs.server;

import javax.ws.rs.ext.ExceptionMapper;
import org.springframework.security.access.AccessDeniedException;

public class SecurityExceptionMapper implements ExceptionMapper<AccessDeniedException> {
    public Response toResponse(AccessDeniedException exception) {
        return Response.status(Response.Status.FORBIDDEN).build();
    }
}
```

3.6. Custom JAX-RS Providers

The custom ExceptionMapper demonstrated in the previous section is a custom JAX-RS provider. Custom MessageBodyReader, MessageBodyWriter and ExceptionMapper providers are most often used.
Custom MessageBodyReader and/or MessageBodyWriter is needed when the JAX-RS runtime needs to read the request messages which has the format not understood or mapped to/from Java classes in a way not supported by by its default readers and writers. Writing a custom reader and writer is not a complex process. For example, a custom MessageBodyReader should be able to answer if it supports reading a message with given MediaType into an object instance of some specific type; if the response is yes then the runtime will ask the provider to read the message from the given input stream.

3.7. Client API

JAX-RS 1.1 does not have a standard Client API. JAX-RS 2.0 will introduce a standard API. CXF JAX-RS offers an HTTP-centric and Proxy-based API. CXF will continue supporting and enhancing its private API for those developers who may want to continue using it even after CXF JAX-RS implements JAX-RS 2.0.

3.7.1. HTTP Centric API

This API lets developers write the HTTP centric code. This fluent API makes it easy to modify the request URI, check the response status and headers. For example:

```java
public class RESTClient {

    public void consumeRESTfulService(String baseAddress) {
        WebClient client = WebClient.create(baseAddress);
        client.type("application/xml").accept("application/xml");
        client.path("/book1");
        // get javax.ws.rs.core.Response directly and check the status, 
        // headers and read the Response.getEntity() input stream  
        Response response = client.get();
        // back to the base address  
        client.back(true);
        client.path("/book2");

        // get a typed response  
        Book response = client.get(Book.class);
    }
}
```

3.7.2. Proxy API

Proxy based API lets reuse the existing JAX-RS annotated interfaces or implementation classes as proxies. The proxy call will lead to a proper URI and HTTP headers passed to the server, exactly the way the JAX-RS annotated service expects. Proxies can also check the actual HTTP Response, modify request URI and headers, as well as be converted to WebClients. For example, given the following sample interface and the client code:
@Path("books")
public interface BookStore {

   @GET  
   @Path("{id}")  
   @Produces("application/xml")  
   Book getBook(@PathParam("id") long id);

   @POST  
   @Consumes("application/xml")  
   Response addBook(Book newBook);

   @Path("all")  
   BookStore getStore();

   @GET  
   Books getAll();
}

public class RESTClient {

   public void consumeRESTfulService(String baseAddress) {
      BookStore proxy =  
         JAXRSClientFactory.create(baseAddress, BookStore.class);

      // get a single book  
      Book book = proxy.getBook(1);

      // further introspect the response headers  
      Client theClient = WebClient.getClient(proxy);  
      javax.ws.rs.core.Response response = theClient.getResponse();  
      checkResponseHeaders(response.getMetadata());

      // add new book  
      Response addNewBookResponse = proxy.addBook(new Book("User Guide"));  
      if (201 == addNewBookResponse.getStatus()) {
         URI bookResourceLocation =  
            URI.create(addNewBookResponse.getMetadata().getFirst("Location"));  
         Book theBookProxy = JAXRSClientFactory.create(  
            bookResourceLocation, Book.class);  
         theBookProxy.getName();  
      } else {
         reportUnexpectedStatus(addNewBookResponse);  
      }

      // get all books  
      BookStore proxy2 = proxy.getStore();  
      Books books = proxy2.getAll();
   }
}

the proxy.getBook(1) call will lead to a ‘GET http://localhost:8080/store/books/1’ HTTP request being sent to the server, with Accept header set to application/xml.

Note the proxy.getStore() and proxy2.getAll() calls. The BookStore.getStore() resource method is a subresource locator as it has only a @Path annotation. This locator returns the BookStore root instance itself. Thus proxy.getStore() only returns a proxy and the subsequent proxy2.getAll() call will lead to the ‘GET http://localhost:8080/store/books/all’ HTTP request being sent.
JAX-RS MessageBodyReader and MessageBodyWriter providers are used to deal with output and input parameters representing HTTP request and response messages, the same way it is done on the server side. Both WebClient and proxy clients can register custom readers and writers if needed, when dealing with custom formats or when the default providers shipped with CXF JAX-RS need to be configured.

For example, a WebClient or proxy call may return a javax.ws.rs.Response instance which usually implies that the client wishes to deal with the HTTP response directly: the status and headers are checked and then the response InputStream returned by default from Response.getEntity() is manually read; in fact, in case of proxies, Response is something a proxy needs to deal with whenever a current proxy method is typed to return Response. Often the Response.getEntity() InputStream can be read by the registered JAX-RS MessageBodyReader providers. This example shows how registering a custom CXF JAX-RS ResponseReader can help:

```java
@Path("books")
public interface BookStore {
  @GET
  @Path("{id}")
  @Produces("application/xml")
  Response getBook(@PathParam("id") long id);
}

public class RESTClient {
  public void consumeRESTfulService(String baseAddress) {
    org.apache.cxf.jaxrs.client.ResponseReader responseReader =
    new org.apache.cxf.jaxrs.client.ResponseReader(Book.class);

    BookStore client = JAXRSClientFactory.create(
        baseAddress, BookStore.class);

    // get a single book
    Response response = client.getBook(1);
    Book book = response.readEntity(Book.class);
  }
}
```

### 3.7.4. Exception Handling

WebClient or proxy based code dealing with explicit javax.ws.rs.core.Response responses is expected to handle the error HTTP responses itself. Usually, the code will check the response status and if the status indicates the error then some action is taken, for example, an exception can be thrown.

If the custom class such as Book is expected to be returned then org.apache.cxf.jaxrs.client.ServerWebApplicationException will be thrown in case of the HTTP response status being equal or greater than 400.

When working with proxies and in particular with methods which may throw custom checked exceptions, one or more org.apache.cxf.jaxrs.client.ResponseExceptionMapper providers can be
registered during the proxy creation. These mappers can convert javax.ws.rs.core.Responses into custom exceptions as required by a given method signature.

Irrespectively of whether the Response or concrete custom class is expected in response to a given call, org.apache.cxf.jaxrs.client.ClientWebApplicationException will be thrown if the invocation has failed on the client side, for example, no connection has been established, no MessageBodyWriter has been found to write the request message or no MessageBodyReader has been found to read the response message, all on the client side.

### 3.8. Working With Attachments

CXF JAX-RS provides a comprehensive support for reading and writing multipart messages. Regular multiparts and XOP attachments are supported.

#### 3.8.1. Reading Attachments

Individual parts can be mapped to StreamSource, InputStream, DataSource or custom Java types for which message body readers are available.

For example:

```java
@POST
@Path("/books/jaxbjson")
@Produces("text/xml")
public Response addBookJaxbJson(
    @Multipart(value = "rootPart", type = "text/xml") Book2 b1,
    @Multipart(value = "book2", type = "application/json") Book b2)
throws Exception {
}
```

Note that in this example it is expected that the root part named ‘rootPart’ is a text-xml Book representation, while a part named ‘book2’ is a Book JSON sequence.

All attachment parts can be accessed as a list of CXF JAX-RS Attachment objects with every Attachment instance providing all the information about a specific part. Similarly, the whole request body can be represented as a CXF JAX-RS MultipartBody:

```java
@POST
public void addAttachments(MultipartBody body) throws Exception {
    List<Attachment> all = body.getAllAttachments();
    Attachment att = body.getRootAttachment();
}
```

When handling complex multipart/form-data submissions (such as those containing files) MultipartBody (and Attachment) need to be used directly.

When working with either List of Attachments or MultipartBody, one may want to process the individual parts with the help of some custom procedures. It is also possible to do the following:
@POST
public void addAttachments(MultipartBody body) throws Exception {
    Book book = body.getAttachmentObject("bookPart", Book.class);
}

@POST
public void addAttachments(List<Attachment> attachments)
    throws Exception {
    for (Attachment attachment : attachments) {
        Book book = attachment.getObject(Book.class);
    }
}

When reading large attachments, the "attachment-directory" and "attachment-memory-threshold" contextual properties can be used to control what folder the attachments exceeding a given threshold (in bytes) can be temporarily saved to.

### 3.8.2. Writing Attachments

It is possible to write attachments to the output stream, both on the client and server sides.

On the server side it is sufficient to update the @Produces value for a given method:

```java
public class Resource {
    private List<Book> books;
    @Produces("multipart/mixed;type=text/xml")
    public List<Book> getBooksAsMultipart() {
        return booksList;
    }

    @Produces("multipart/mixed;type=text/xml")
    public Book getBookAsMultipart() {
        return booksList;
    }
}
```

Note that a 'type' parameter of the 'multipart/mixed' media type indicates that all parts in the multiparts response should have a Content-Type header set to 'text/xml' for both getBooksAsMultipart() and getBookAsMultipart() method responses. The getBooksAsMultipart() response will have 3 parts, the first part will have its Content-ID header set to "root.message@cxf.apache.org", the next parts will have '1' and '2' ids. The getBookAsMultipart() response will have a single part only with its Content-ID header set to "root.message@cxf.apache.org".

When returning mixed multiparts containing objects of different types, you can either return a Map with the media type string value to Object pairs or MultipartBody:

```java
public class Resource {
    private List<Book> books;
    @Produces("multipart/mixed")
    public Map<String, Object> getBooks() {
        Map<String, Object> map = new LinkedHashMap<String, Object>();
        map.put("text/xml", new JaxbBook());
    }
}
```
map.put("application/json", new JSONBook());
map.put("application/octet-stream", imageInputStream);
return map;
}

@Produces("multipart/mixed")
public MultipartBody getBooks2() {
    List<Attachment> atts = new LinkedList<Attachment>();
    atts.add(new Attachment("root", "application/json",
        new JSONBook()));
    atts.add(new Attachment("image", "application/octet-stream",
        getImageInputStream()));
    return new MultipartBody(atts, true);
}
}

Similarly to the method returning a list in a previous code fragment, getBooks() will have the response serialized as multipart, where the first part will have its Content-ID header set to "root.message@cxf.apache.org", the next parts will have ids like '1', '2', etc.

In getBooks2() one can control the content ids of individual parts.

You can also control the contentId and the media type of the root attachment by using a Multipart annotation:

public class Resource {
    @Produces("multipart/form-data")
    @Multipart(value = "root", type = "application/octet-stream")
    public File testGetImageFromForm() {
        return getClass().getResource("image.png").getFile();
    }
}

One can also have lists or maps of DataHandler, DataSource, Attachment, byte arrays or InputStreams handled as multipart.

On the client side multipart can be written the same way. For example:

WebClient client = WebClient.create("http://books");
client.type("multipart/mixed").accept("multipart/mixed");
List<Attachment> atts = new LinkedList<Attachment>();
atts.add(new Attachment("root", "application/json",
    new JSONBook()));
atts.add(new Attachment("image", "application/octet-stream",
    getImageInputStream()));
List<Attachment> atts = client.postAndGetCollection(atts, Attachment.class);

When using proxies, a Multipart annotation attached to a method parameter can also be used to set the root contentId and media type. Proxies do not support at the moment multiple method parameters annotated with Multipart (as opposed to the server side) but only a single multipart parameter:

public class Resource {
    @Produces("multipart/mixed")
    @Consumes("multipart/form-data")
@Multipart(value = "root", type = "application/octet-stream")
public File postGetFile(@Multipart(value = "root2", type = "application/octet-stream") File file) {}

A method-level Multipart annotation will affect the writing on the server side and the reading
on the client side. A parameter-level Multipart annotation will affect writing on the client (proxy)
side and reading on the server side. You don’t have to use Multipart annotations.

3.8.3. Uploading files

At the moment the only way to upload a file is to use a MultipartBody, Attachment or File:

```java
WebClient client = WebClient.create("http://books");
client.type("multipart/form-data");
ContentDisposition cd = new ContentDisposition(
    "attachment;filename=image.jpg");
Attachment att = new Attachment("root", imageInputStream, cd);
client.post(new MultipartBody(att));

// or just post the attachment if it's a single part request only
client.post(att);

// or just use a file
client.post(getClass().getResource("image.png").getFile());
```

Using File provides a simpler way as the runtime can figure out how to create a ContentDisposition
from a File.

3.8.4. Forms and multiparts

The Forms in HTML documents recommendation suggests that multipart/form-data requests
should mainly be used to upload files.

One way to deal with multipart/form-data submissions is to deal directly with a CXF JAXRS
Attachment class and get a Content-Disposition header and/or the underlying input stream.
It is also possible to have individual multipart/form-data parts read by registered JAX-RS
MessageBodyReaders, something that is already possible to do for types like multipart/mixed or
multipart/related. For example, this payload:

```text
--bqJky99m1BWa-ZuqjC53mG6EzbmlxB
Content-Disposition: form-data; name="bookJson"
Content-Type: application/json; charset=US-ASCII
Content-Transfer-Encoding: 8bit
Content-ID: <jsonPart>

{"Book":{"name":"CXF in Action - 1","id":123}}

--bqJky99m1BWa-ZuqjC53mG6EzbmlxB
```
can be handled by the following method:

```java
@POST
@Path("/books/jsonjaxbform")
@Consumes("multipart/form-data")
public Response addBookJaxbJsonForm(@Multipart("jsonPart") Book b1,
    @Multipart("bookXML") Book b2) {

    Note that once a request has more than two parts then one needs to start using @Multipart, the
    values can refer to either ContentId header or to ContentDisposition/name. At the moment using
    @Multipart is preferred to using @FormParam unless a plain name/value submission is dealt
    with. The reason is that @Multipart can also specify an expected media type of the individual
    part and thus act similarly to a @Consume annotation.

    When dealing with multiple parts one can avoid using @Multipart and just use List<Attachment>,
    List<Book>, etc.

    Finally, multipart/form-data requests with multiple files (file uploads) can be supported. For
    example, this payload:

    --bqJky99mlBWa-ZuqjC53mG6EzbmlxB
    Content-Disposition: form-data; name="owner"
    Content-Type: text/plain
    Larry
    --bqJky99mlBWa-ZuqjC53mG6EzbmlxB
    Content-Disposition: form-data; name="files"
    Content-Type: multipart/mixed; boundary=_Part_4_701508.1145579811786
    --_Part_4_701508.1145579811786
    Content-Disposition: form-data; name="book1"
    Content-Type: application/json; charset=US-ASCII
    Content-Transfer-Encoding: 8bit
    {"Book":{"name":"CXF in Action - 1","id":123}}
    --_Part_4_701508.1145579811786
    Content-Disposition: form-data; name="book2"
    Content-Type: application/json; charset=US-ASCII
    Content-Transfer-Encoding: 8bit
    {"Book":{"name":"CXF in Action - 2","id":124}}
    --_Part_4_701508.1145579811786--
    --bqJky99mlBWa-ZuqjC53mG6EzbmlxB--

    can be handled by the following method:

    @POST
    @Path("/books/filesform")
    @Produces("text/xml")
```
If you need to know the names of the individual file parts embedded in a "files" outer part (such as "book1" and "book2"), then please use List<Attachment> instead. It is currently not possible to use a Multipart annotation to refer to such inner parts but you can easily get the names from the individual Attachment instances representing these inner parts.

Note that it is only the last request which has been structured according to the recommendation on how to upload multiple files but it is more complex than the other simpler requests linked to in this section.

Please note that using JAX-RS FormParams is recommended for dealing with plain application/www-url-encoded submissions consisting of name/value pairs only.

### 3.8.5. XOP support

CXF JAXRS clients and endpoints can support XML-binary Optimized Packaging (XOP). What it means at the practical level is that a JAXB bean containing binary data is serialized using a multipart packaging, with the root part containing non-binary data only but also linking to co-located parts containing the actual binary payloads. Next it is deserialized into a JAXB bean on the server side.

If you would like to experiment with XOP then you need to set an "mtom-enabled" property on CXF jaxrs endpoints and clients.

### 3.9. Configuration

CXF JAX-RS endpoints and clients can be configured declaratively (using Spring or web.xml only) and programmatically.

#### 3.9.1. Configuration of Endpoints

Providing a custom javax.ws.rs.core.Application implementation is the only portable way to register root resource and provider classes and indicate what lifecycle model the individual resources follow. For example:

```java
package server;
import java.util.HashSet;
import java.util.Set;
import javax.ws.rs.core.Application;
```
public class BookApplication extends Application {

    @Override
    public Set<Class<?>> getClasses() {
        Set<Class<?>> classes = new HashSet<Class<?>>();
        classes.add(BookStore.class);
        return classes;
    }

    @Override
    public Set<Object> getSingletons() {
        Set<Object> classes = new HashSet<Object>();
        classes.add(new SearchService());
        classes.add(new BookExceptionMapper());
        return classes;
    }
}

The BookApplication indicates to the runtime that BookStore root resource has the per-request lifecycle. The SearchService root resource and BookExceptionMapper provider are singletons. In CXF one can register JAX-RS Applications in web.xml using a CXFNonSpringJaxrsServlet:

```xml
<servlet>
    <servlet-name>CXFServlet</servlet-name>
    <display-name>CXF Servlet</display-name>
    <servlet-class>
        org.apache.cxf.jaxrs.servlet.CXFNonSpringJaxrsServlet
    </servlet-class>
    <init-param>
        <param-name>javax.ws.rs.Application</param-name>
        <param-value>server.BookApplication</param-value>
    </init-param>
</servlet>
```

Spring users can configure the JAX-RS endpoints using one or more jaxrs:server declarations:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:jaxrs="http://cxf.apache.org/jaxrs"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
                        http://www.springframework.org/schema/beans/spring-beans.xsd
                        http://cxf.apache.org/jaxrs
                        http://cxf.apache.org/schemas/jaxrs.xsd">
    <import resource="classpath:META-INF/cxf/cxf.xml"/>
    <import resource="classpath:META-INF/cxf/cxf-extension-jaxrs-binding.xml"/>
    <import resource="classpath:META-INF/cxf/cxf-servlet.xml"/>

    <bean class="org.apache.cxf.systest.jaxrs.BookStore" id="serviceBean"/>
    <bean class="org.apache.cxf.systest.jaxrs.provider.JAXBElementProvider" id="jaxbProvider">
        <!-- customize the default JAXBElementProvider by setting some of its properties -->
    </bean>
</beans>
```
A single JAX-RS endpoint is registered with a jaxrs:server declaration. This declaration may reference multiple root resource beans with jaxrs:serviceBeans and multiple providers using jaxrs:providers. Note a jaxrs:server/@address attribute. It allows for registering multiple jaxrs:server endpoints with all of them referencing the same service beans but using differently configured JAX-RS providers.

The jaxrs:server endpoints can register CXF features, in and out CXF interceptors.

### 3.9.2. Configuration of Clients

CXF JAX-RS clients can be configured programmatically or from Spring.

Configuring the clients from Spring often implies that the client instances are injected into JAX-RS or JAX-WS endpoints so that the incoming request can be further delegated to the RESTful service. Both proxies and WebClient instances can be configured from Spring:
3.10. Tutorials

3.10.1. Creating a Basic JAX-RS endpoint

When starting with the JAX-RS development, trying to visualize or model the way the RESTful resources will be accessed can be helpful. One simple approach is to draw a table against each resource and list the HTTP verbs, formats and URIs this resource will support. The other approach is to try to imagine what part of the application URI space will need to be supported by a dedicated handler.

These handlers will be mapped to JAX-RS root resource classes. For example, assuming "/books" and "/book" URI segments need to be supported, then one can imagine the developer starting to work on the following two root resource classes, alongside with a couple of simple beans:

```java
/**
 * The Book JAXB bean.
 **/
@XmlRootElement(name = "book", namespace = "http://books")
public class Book {
    private String name;
    private String author;
    private Date publicationDate;
    private List<String> reviews;
    // setters and getters are omitted
}

/**
 * The Collection of Book instances.
 **/
@XmlRootElement(name = "books", namespace = "http://books")
public class Books {
    // XmlJavaTypeAdapter is available
    private Map<Long, Book> books =
        Collections.synchronizedMap(new HashMap<Long, Book>());

    public void addBook(Long id, Book b) {
        books.put(id, b);
    }

    public Book getBook(Long id) {
        return books.get(id);
    }

    public void deleteBook(Long id) {
        books.remove(id);
    }

    public void addBookReview(Long id, String review) {
        getBook(id).addReview(review);
    }
```
@Path("/books")
public class BooksStore {
    private static AtomicLong ID = new AtomicLong();
    private Books books;

    // Thread-safe UriInfo instance providing the
    // extended information about the current URI
    @Context
    private UriInfo uriInfo;

    /**
     * Injects the Books storage
     **/
    public void setBooks(Books books) {
        this.books = books;
    }

    /**
     * Returns the list of all the books
     **/
    @GET
    @Produces("application/xml")
    public Books getAllBooks() {
        return books;
    }

    /**
     * Adds a new Book to the internal storage and returns
     * an HTTP Location header pointing to a new Book resource.
     **/
    @POST
    @Consumes("application/xml")
    public Response addBook(Book book) {
        // New Book ID
        Long id = ID.incrementAndGet();
        books.add(id, book);

        // Get the base URI of the application and wrap it into a builder.
        // UriBuilder makes it easy to compose new URIs.
        UriBuilder builder = uriInfo.getBaseUriBuilder();

        // Build a new book resource URI
        // with say a '/book/1' segment added to the base URI
        builder.path("/book/" + id);
        URI newBookResourceURI = builder.build();

        // Return 201 and the Location header
        return Response.created().location(newBookResourceURI).build();
    }
}
@Path("/book")
public class BookHandler {
  private Books books;

  /**
   * Injects the Books storage
   **/
  public void setBooks(Books books) {
    this.books = books;
  }

  @GET
  @Produces("application/xml")
  @Path("{id}")
  public Book getBook(@PathParam("id") Long id) {
    return books.getBook(id);
  }

  @PUT
  @Consumes("text/plain")
  @Path("{id}")
  public void setBookReview(@PathParam("id") Long id, String review) {
    books.addBookReview(review);
  }

  @DELETE
  @Path("{id}")
  public void deleteBook(@PathParam("id") Long id) {
    books.deleteBook(id);
  }
}

The developer has prototyped two root resource classes, BooksStore and BookHandler. Next the configuration for the new JAX-RS endpoint has been added (see below for the example), the store.war has been built and deployed to a servlet container listening on localhost:8080. Given that the name of the war, ‘store’ in this case, contributes to the URI path, the base URI of the Store application is http://localhost:8080/store.

The BookStore will handle HTTP GET requests with the URIs such as http://localhost:8080/store/books and return the list of Books in the XML format. It will also accept POST requests with new Books being submitted in the XML format to http://localhost:8080/store/books.

The BookStore.getAllBooks() method implementation is simple, while BookStore.addBook(Book) is a bit more involved, but it simply follows a basic pattern to do with adding new resources. Particularly, POST usually adds new resources and the typical response is to return a 201 status with the Location header pointing to a new resource URI. For example, if the new Book id is "1" then given that the base URI is http://localhost:8080/store/, the unique resource URI of the new Book resource will be http://localhost:8080/store/book/1.

The client code or browser script which was used to add the new Book can choose to follow the http://localhost:8080/store/book/1 using GET. In this case another root resource, BookHandler will handle GET, as well as PUT and DELETE requests, all targeted at the individual Book resources.

Note that instead of introducing a dedicated BookHandler root resource supporting the URIs such as '/book/1', the developer could have opted for supporting 'books/1' URIs instead, and thus all the BookHandler methods could have been implemented as part of the BooksStore class. For example:
@Path("/books")
public class BooksStore {

@Path("/{id}")
@PUT
@Consumes("text/plain")
public void setBookReview(@PathParam("id") Long id, String review) {...}

@Path("/{id}")
@DELETE
public void deleteBook(@PathParam("id") Long id) {...}

...
}

Many options are available and JAX-RS makes it easy for developers to structure their Java web services applications as needed.

And here is how the JAX-RS endpoint can be configured:

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:jaxrs="http://cxf.apache.org/jaxrs"
  xsi:schemaLocation="
  http://www.springframework.org/schema/beans
  http://www.springframework.org/schema/beans/spring-beans.xsd
  http://cxf.apache.org/jaxrs
  http://cxf.apache.org/schemas/jaxrs.xsd">
  <import resource="classpath:META-INF/cxf/cxf.xml" />
  <import resource= "classpath:META-INF/cxf/cxf-extension-jaxrs-binding.xml"/>
  <import resource="classpath:META-INF/cxf/cxf-servlet.xml" />

  <bean class="org.books.BooksStore" id="storeBean"/>
  <bean class="org.books.BookHandler" id="bookBean"/>

  <jaxrs:server id="bookservice" address=""/>
  <jaxrs:serviceBeans>
    <ref bean="storeBean" />
    <ref bean="bookBean" />
  </jaxrs:serviceBeans>
</beans>
```

Please also see a jaxrs_intro demo in the TSF Examples distribution.
Chapter 4. JAX-RS and OAuth2

CXF 2.6.0 provides an initial implementation of OAuth 2.0. See also the CXF Website for information about OAuth 1.0. Authorization Code, Implicit and Client Credentials grants are currently supported with other grant handlers to be added later. Custom grant handlers can also be registered.

OAuth2 is a new protocol which offers a complex yet elegant solution toward helping end users (resource owners) authorize third-party providers to access their resources. The OAuth2 flow is closely related to the original OAuth 1.0 3-leg flow is called Authorization Code and involves 3 parties: the end user, the third party service (client) and the resource server which is protected by OAuth2 filters. Typically a client offers a service feature that an end user requests and which requires the former to access one or more protected resources on behalf of this user which are located at the resource server. For example, the client may need to access the end user’s photos in order to print them and post to the user or read and possibly update a user’s calendar in order to make a booking.

In order to make it happen, the third-party service application/client needs to register itself with the OAuth2 server. This happens out-of-band and after the registration the client gets back a client key and secret pair. Typically the client is expected to provide the name and description of the application, the application logo URI, one or more redirect URIs, and other information that may help the OAuth2 authorization server to identify this client to the end user at the authorization time. From then on, the authorization code flow works like this:

1. End User requests the third-party service using a browser.
2. The client redirects the end user to OAuth2 Authorization Service, adding its client id, the state, redirect URI and the optional scope to the target URI. The state parameter represents the current end user’s request, redirect URI - where the authorization code is expected to be returned to, and the scope is the list of opaque permissions that the client needs in order to access the protected resources.
3. Authorization Service will retrieve the information about the client using its client id, build an HTML form and return it to the end user. The form will ask the user if a given third-party application can be allowed to access some resources on behalf of this user.
4. If the user approves it then Authorization Service will generate an authorization code and redirect the user back to the redirect uri provided by the client, also adding a state parameter to the redirect URI.
5. The client requests an access token from OAuth2 Access Token Service by providing an authorization code grant.
6. After getting an access token token, the service finally proceeds with accessing the current user’s resources and completes the user’s request.

As you can see the flow can be complex yet it is very effective. A number of issues may need to be taken care along the way such as managing expired tokens, making sure that the OAuth2 security layer is functioning properly and is not interfering with the end user itself trying to access its own resources, etc. Please check the specification and the Wikipedia article as well as other resources available on the WEB for more information you may need to know about OAuth2.
CXF JAX-RS gives the best effort to making this process as simple as possible and requiring only a minimum effort on behalf of OAuth2 server developers. It also offers the utility code for greatly simplifying the way the third-party application can interact with the OAuth2 service endpoints.

Maven dependency needed for CXF’s implementation of OAuth2:

```xml
<dependency>
    <groupId>org.apache.cxf</groupId>
    <artifactId>cxf-rt-rs-security-oauth2</artifactId>
    <version>2.6.0</version>
</dependency>
```
4.1. Developing OAuth2 Servers

The OAuth2 server is the core piece of the complete OAuth2-based solution. Typically it contains 2 services for:

1. Authorizing request tokens by asking the end users to let clients access some of their resources and returning the grants back to the client (Authorization Service)

2. Exchanging the token grants for access tokens (Access Token Service)

CXF offers several JAX-RS service implementations that can be used to create the OAuth2 servers fast: AuthorizationCodeGrantService and ImplicitGrantService for managing the redirection-based flows, as well as AccessTokenService for exchanging the grants for new tokens. Note that some grants that do not require the redirection-based support, such as SAML2 one, etc, may only require an Access Token Service be operational.

All of these services rely on the custom OAuthDataProvider which persists the access tokens and converts the opaque scope values to the information that can be presented to the users. Additionally, AuthorizationCodeDataProvider is an OAuthDataProvider which can keep temporary information about the authorization code grants which needs to be removed after the tokens are requested in exchange.

Writing your own OAuthDataProvider implementation is what is needed to get the OAuth2 server up and running. In many cases all you need to do is to persist or remove the Authorization Code Grant data, use one of the available utility classes to create a new access token and also persist it or remove the expired one, and finally convert the optional opaque scope values (if any are supported) to a more view-able information.

4.1.1. Authorization Service

The main responsibility of OAuth2 Authorization Service is to present an end user with a form asking the user to allow or deny the client accessing some of the user resources. CXF offers AuthorizationCodeGrantService and ImplicitGrantService for accepting the redirection requests, challenging the end users with the authorization forms, handling the end user decisions and returning the results back to the clients.

One of the differences between the AuthorizationCode and Implicit flows is that in the latter case the grant is the actual access token which is returned as the URI fragment value. The way the end user is asked to authorize the client request is similar between the two flows. In this section we will assume that the Authorization Code flow is being exercised.

A third-party client redirects the current user to AuthorizationCodeGrantService, for example, here is how a redirection may happen:

```
Response-Code: 303
Headers: {Location=[http://localhost:8080/services/social/authorize?client_id=123456789&scope=updateCalendar-7&response_type=code&redirect_uri=http%3A//localhost%3A8080/services/reservations/reserve/complete&state=1],Date=[Thu, 12 Apr 2012 12:26:21 GMT],Content-Length=[0]}
```
The client application asks the current user (the browser) to go to a new address provided by the Location header and the follow-up request to AuthorizationCodeGrantService will look like this:

```
Address: http://localhost:8080/services/social/authorize?client_id=123456789&scope=updateCalendar-7&response_type=code&redirect_uri=http%3A//localhost%3A8080/services/reservations/reserve/complete&state=1
Http-Method: GET
Headers: {
Accept=text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8, 
Authorization=Basic YmFycnlAc29jaWFsLmNvbToxMjM0, 
Cookie=JSESSIONID=suj2wyl54c4g, 
Referer=http://localhost:8080/services/forms/reservation.jsp
...}
```

Note that the end user needs to authenticate. The Request URI includes the client_id, custom scope value, response_type set to ‘code’, the current request state and the redirect uri. Note the scope is optional - the Authorization Service will usually allocate a default scope; however even if the client does include an additional custom scope the end user may still not approve it. The redirect uri is also optional, assuming one or more ones redirect URIs have been provided at the client registration time.

AuthorizationCodeGrantService will report a warning if no secure HTTPS transport is used:

```
12-Apr-2012 13:26:21
org.apache.cxf.rs.security.oauth2.services.AbstractOAuthService
checkTransportSecurity
WARNING: Unsecure HTTP, Transport Layer Security is recommended
```

It can also be configured to reject the requests over un-secure HTTP transport.

AuthorizationCodeGrantService will retrieve the information about the client application to populate an instance of OAuthAuthorizationData bean and return it. OAuthAuthorizationData contains application name and URI properties, optional list of Permissions and other properties which can be either presented to the user or kept in the hidden form fields in order to uniquely identify the actual authorization request when the end user returns the decision.

One important OAuthAuthorizationData property is "authenticityToken". It is used for validating that the current session has not been hijacked - AuthorizationCodeGrantService generates a random key, stores it in a Servlet HTTPSession instance and expects the returned authenticityToken value to match it - this is a recommended approach and it also implies that the authenticityToken value is hidden from a user, for example, it’s kept in a ‘hidden’ form field. The other properties which are meant to be hidden are clientId, state, redirectUri, proposedScope. The helper "replyTo" property is an absolute URI identifying the AuthorizationCodeGrantService handler processing the user decision and can be used by view handlers when building the forms or by other OAuthAuthorizationData handlers.

So the populated OAuthAuthorizationData is finally returned. Note that it’s a JAXB XMLRootElement-annotated bean and can be processed by registered JAXB or JSON providers given that AuthorizationCodeGrantService supports producing “application/xml” and “application/json” (See the OAuth Without Browser section below for more). But in this case we have the end user working with a browser so an HTML form is what is really expected back.

AuthorizationCodeGrantService supports producing “text/html” and simply relies on a registered RequestDispatcherProvider to set the OAuthAuthorizationData bean as an HttpServletRequest attribute and redirect the response to a view handler (can be JSP or some other servlet) to actually
build the form and return it to the user. Alternatively, registering XSLTJaxbProvider would also be a good option for creating HTML views.

Assuming RequestDispatcherProvider is used, the following example log shows the initial response from AuthorizationCodeGrantService:

```
RequestDispatcherProvider logRedirection
INFO: Setting an instance of "org.apache.cxf.rs.security.oauth2.common.
OAuthAuthorizationData" as HttpServletRequest attribute "data" and
redirecting the response to "/forms/oauthAuthorize.jsp".
```

Note that a "/forms/oauthAuthorize.jsp" view handler will create an HTML view - this is a custom JSP handler and whatever HTML view is required can be created there, using the OAuthAuthorizationData bean for building the view. Most likely you will want to present a form asking the user to allow or deny the client accessing some of this user's resources. If OAuthAuthorizationData has a list of Permissions set then adding the information about the permissions is needed.

Next the user makes a decision and selects a button allowing or denying the client accessing the resources. The form data are submitted to AuthorizationCodeGrantService:

```
Address: http://localhost:8080/services/social/authorize/decision
Encoding: ISO-8859-1
Http-Method: POST
Content-Type: application/x-www-form-urlencoded
Headers: {
Authorization=[Basic YmFycnlAc29jaWFsLmNvbToxMjM0],
Content-Type=[application/x-www-form-urlencoded],
...}
```

```
12-Apr-2012 15:36:29 org.apache.cxf.jaxrs.utils.FormUtils
logRequestParametersIfNeeded
INFO: updateCalendar-7_status=allow&readCalendar_status=allow
&scope=updateCalendar-7+readCalendar
&redirect_uri=http%3A%2F%2Flocalhost%3A8080%2Fservices%2F
reservations%2Fcomplete
&session_authenticity_token=4f0005d9-565f-4309-8ffb-c13c72139eb
/oauthDecision=allow
&state=1&client_id=123456789
```

AuthorizationCodeGrantService will use a session_authenticity_token to validate that the session is valid and will process the user decision next.

If the decision is "allow" then it will check the status of the individual scope values. It relies on the "scopename_status" convention, if the form has offered the user a chance to selectively enable individual scopes then name/value pairs such as "updateCalendar-7_status=allow" are submitted. If none of such pairs is coming back then it means the user has approved all the default and additional (if any) scopes. Next it will ask OAuthDataProvider to generate an authorization code grant and return it alongside with the state if any by redirecting the current user back to the redirect URI:

```
Response-Code: 303
Headers: {
  Location=[http://localhost:8080/services/reservations/reserve/complete
?state=1&code=5c993144b910bccd5977131f7d2629ab],
  Date=[Thu, 12 Apr 2012 14:36:29 GMT],
  Content-Length=[0]}
```
Which leads to a browser redirecting the user:

```
Address: http://localhost:8080/services/reservations/reserve/complete?state=1&code=5c993144b910bccd5977131f7d2629ab
Http-Method: GET
Headers: {
Accept=[text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8],
Authorization=[Basic YmFycnlAcmVzdGF1cmFudC5jb206NTY3OA==],
Cookie=[JSESSIONID=1c289vha0cxfe],
}
```

If a user decision was set to "deny" then the error will be returned to the client. Assuming the decision was "allow", the client has now received back the authorization code grant and is ready to exchange it for a new access token.

### 4.1.2. AccessTokenService

The role of AccessTokenService is to exchange a token grant for a new access token which will be used by the client to access the end user’s resources. Here is an example request log:

```
Address: http://localhost:8080/services/oauth/token
Http-Method: POST
Headers: {
Accept=[application/json],
Authorization=[Basic MTIzNDU2Nzg5Ojk4NzY1NDMyMw==],
Content-Type=[application/x-www-form-urlencoded]
}
Payload:
grant_type=authorization_code&code=5c993144b910bccd5977131f7d2629ab
&redirect_uri=http%3A%2F%2Flocalhost%3A8080%2Fservices%2Freservations%2Fcomplete
```

This request contains a client_id and client_secret (Authorization header), the grant_type, the grant value (code) plus the redirect URI the authorization grant was returned to which is needed for the additional validation. Note that the alternative client authentication methods are also possible, in this case the token service will expect a mapping between the client credentials and the client_id representing the client registration available.

After validating the request, the service will find a matching AccessTokenGrantHandler and request to create a ServerAccessToken which is a server-side representation of the access token. The grant handlers, such as AuthorizationCodeGrantHandler may delegate the creation of the actual access token to data providers, which may create Bearer or MAC tokens with the help of utility classes shipped with CXF or depend on other 3rd party token libraries.

The data providers are not strictly required to persist the data such as access tokens, instead the token key may act as an encrypted bag capturing all the relevant information.

Now that the token has been created, it is mapped by the service to a client representation and is returned back as a JSON payload:

```
Response-Code: 200
Content-Type: application/json
Headers: {
```
The client will use this access token to access the current user’s resources in order to complete the original user’s request, for example, the request to access a user’s calendar may look like this:

Address: http://localhost:8080/services/thirdPartyAccess/calendar
Http-Method: GET
Headers:
{  
  Authorization=[Bearer 5b5c8e677413277c4bb8b740d522b378],  
  Accept=[application/xml]
}

Note that the access token key is passed as the Bearer scheme value. Other token types such as MAC ones, etc, can be represented differently.

### 4.1.2.1. Access Token Types

As mentioned above, AccessTokenService can work with whatever token is created by a given data provider. This section provides more information on how CXF may help with supporting Bearer and MAC tokens.

#### Bearer

The following code fragment shows how a `BearerAccessToken` utility class can be used to create Bearer tokens:

```java
import org.apache.cxf.rs.security.oauth2.common.AccessTokenRegistration;
import org.apache.cxf.rs.security.oauth2.common.ServerAccessToken;
import org.apache.cxf.rs.security.oauth2.tokens.bearer.BearerAccessToken;

public class CustomOAuthDataProvider implements AuthorizationCodeDataProvider {

    public ServerAccessToken createAccessToken(AccessTokenRegistration reg)
        throws OAuthServiceException {

        ServerAccessToken token = new BearerAccessToken(reg.getClient(), 3600L);

        List<String> scope = reg.getApprovedScope().isEmpty() ?
            reg.getRequestedScope() : reg.getApprovedScope();
        token.setScopes(convertScopeToPermissions(reg.getClient(), scope));
        token.setSubject(reg.getSubject());
        token.setGrantType(reg.getGrantType());

        // persist as needed and then return
        return token;
    }
}
```
CustomOAuthDataProvider will also be asked by OAuthRequestFilter to validate the incoming Bearer tokens given that they typically act as database key or key alias, if no Bearer token validator is registered.

### MAC

CXF 2.6.2 supports MAC tokens as specified in the latest MAC Access Authentication draft. MAC tokens offer an option for clients to demonstrate they ‘hold’ the token secret issued to them by AccessTokenService. It is recommended that AccessTokenService endpoint issuing MAC tokens enforces a two-way TLS for an extra protection of the MAC token data returned to clients.

The following code fragment shows how a `MacAccessToken` utility class can be used to create MAC tokens:

```java
import org.apache.cxf.rs.security.oauth2.common.AccessTokenRegistration;
import org.apache.cxf.rs.security.oauth2.common.ServerAccessToken;
import org.apache.cxf.rs.security.oauth2.tokens.mac.HmacAlgorithm;
import org.apache.cxf.rs.security.oauth2.tokens.mac.MacAccessToken;

public class CustomOAuthDataProvider implements AuthorizationCodeDataProvider {
    public ServerAccessToken createAccessToken(AccessTokenRegistration reg)
            throws OAuthServiceException {
        // generate
        ServerAccessToken token = new MacAccessToken(reg.getClient(),
                HmacAlgorithm.HmacSHA1, 3600L);

        // set other token fields as shown in the Bearer section
        // persist as needed and then return
        return token;
    }
}
```

One can expect the following response:

```plaintext
Response-Code: 200
Content-Type: application/json
Headers: {
    Cache-Control=[no-store],
    Pragma=[no-cache],
    Date=[Thu, 12 Apr 2012 14:36:29 GMT]
}

Payload:
{
    "access_token":"5b5c8e677413277c4bb8b740d522b378",  "token_type":"mac",
    "secret":"1234568",  algorithm="hmac-sha-1"
}
```

Note that ‘access_token’ is the MAC key identifier, ‘secret’ - MAC key.
MacAccessTokenValidator has to be registered with OAuthRequestFilter for validating the incoming MAC tokens. This validator can get a reference to custom NonceVerifier with CXF possibly shipping a default implementation in the future.

The client can use CXF OAuthClientUtils to create Authorization MAC headers. All is needed is to provide references to ClientAccessToken representing the MAC token issued by AccessTokenService and HttpRequestProperties capturing the information about the current request URI:

```java
String requestURI = "http://localhost:8080/calendar";
WebClient wc = WebClient.create(requestURI);

// represents client registration
OAuthClientUtils.Consumer consumer = getConsumer();
// the token issued by AccessTokenService
ClientAccessToken token = getToken();

HttpRequestProperties httpProps = new HttpRequestProperties(wc, "GET");
String authHeader = OAuthClientUtils.createAuthorizationHeader(consumer, token, httpProps);
wC.header("Authorization", authHeader);
Calendar calendar = wc.get(Calendar.class);
```

This code will result in something like:

```
GET /calendar HTTP/1.1
Host: localhost
Accept: application/xml
Authorization: MAC id="5b5c8e677413277c4bb8b740d522b378",
nonce="273156:di3hvdf8",
mac="W7bdMZbv9UWOTadASIHQag2yirA="
ext="12345678"
```

where the 'ext' attribute is used to pass a timestamp value.

### 4.1.2.2. Writing OAuthDataProviders

Using CXF OAuth service implementations will help a lot with setting up an OAuth server. As you can see from the above sections, these services rely on a custom OAuthDataProvider implementation.

The main task of OAuthDataProvider is to persist and generate access tokens. Additionally, as noted above, AuthorizationCodeDataProvider needs to persist and remove the code grant registrations. The way it's done is really application-specific. Consider starting with a basic memory based implementation and then move on to keeping the data in some DB.

Note that OAuthDataProvider supports retrieving Client instances but it has no methods for creating or removing Clients. The reason for it is that the process of registering third-party clients is very specific to a particular OAuth2 application, so CXF does not offer a registration support service and hence OAuthDataProvider has no Client create/update methods. You will likely need to do something like this:

```java
public class CustomOAuthProvider implements OAuthDataProvider {
    public Client registerClient(String applicationName,
```
CustomOAuthProvider will also remove all tokens associated with a given Client in removeClient(String clientId).

Finally OAuthDataProvider may need to convert opaque scope values such as "readCalendar" into a list of OAuthPermissions. AuthorizationCodeGrantService and OAuth2 security filters will depend on it (assuming scopes are used in the first place). In the former case AuthorizationCodeGrantService will use this list to populate OAuthAuthorizationData - the reason this bean only sees Permissions is that some of the properties OAuthPermission keeps are of no interest to OAuthAuthorizationData handlers.

### 4.1.3. OAuth Server JAX-RS endpoints

With CXF offering OAuth service implementations and a custom OAuthDataProvider provider in place, it is time to deploy the OAuth2 server. Most likely, you'd want to deploy AccessTokenService as an independent JAX-RS endpoint, for example:

```
<!-- implements OAuthDataProvider -->
<bean id="oauthProvider" class="oauth.manager.OAuthManager"/>

<bean id="accessTokenService" class="org.apache.cxf.rs.security.oauth2.services.AccessTokenService">
  <property name="dataProvider" ref="oauthProvider"/>
</bean>

<jaxrs:server id="oauthServer" address="/oauth">
  <jaxrs:serviceBeans>
    <ref bean="accessTokenService"/>
  </jaxrs:serviceBeans>
</jaxrs:server>
```

AccessTokenService listens on a relative "/token" path. Given that jaxrs:server/@adress is "/oauth" and assuming a context name is "/services", the absolute address of AccessTokenService would be something like http://localhost:8080/services/oauth/token.

AuthorizationCodeGrantService is better to put where the main application endpoint is. It can be put alongside AccessTokenService - but the problem is that the end user is expected to authenticate itself with the resource server after it has been redirected by a third-party client to AuthorizationCodeGrantService. That would make it more complex for the OAuth server endpoint to manage both OAuth (third-party client) and the regular user authentication - that can be done, see more on it below in the Design considerations section, but the simpler option is to simply get AuthorizationCodeGrantService under the control of the security filter enforcing the end user authentication:

```
<bean id="authorizationService" class="org.apache.cxf.rs.security.oauth2.services..AuthorizationCodeGrantService">
  <property name="dataProvider" ref="oauthProvider"/>
</bean>
```
AuthorizationCodeGrantService listens on a relative /authorize path so in this case its absolute address will be something like http://localhost:8080/services/myapp/authorize. This address and that of AccessTokenService will be used by third-party clients.

4.2. Protecting resources with OAuth2 filters

OAuthRequestFilter request handler can be used to protect the resource server when processing the requests from the third-party clients. Add it as a jaxrs:provider to the endpoint which deals with the clients requesting the resources. When checking a request like this:

Address: http://localhost:8080/services/thirdPartyAccess/calendar
Http-Method: GET
Headers:
{
  Authorization=[Bearer 5b5c8e677413277c4bb8b740d522b378],
  Accept=[application/xml]
}

the filter will do the following:

1. Retrieve a ServerAccessToken by delegating to a matching registered AccessTokenValidator. AccessTokenValidator is expected to check the validity of the incoming token parameters and possibly delegate to OAuthDataProvider to find the token representation - this is what the filter will default to if no matching AccessTokenValidator is found and the Authorization scheme is 'Bearer'.

2. Check the token has not expired

3. AccessToken may have a list of OAuthPermissions. For every permission it will:
   • If it has a uri property set then the current request URI will be checked against it
   • If it has an httpVerb property set then the current HTTP verb will be checked against it

4. Finally, it will create a CXF SecurityContext using this list of OAuthPermissions, the UserSubject representing the client or the end user who authorized the grant used to obtain this token.

This SecurityContext will not necessarily be important for some of OAuth2 applications. Most of the security checks will be done by OAuth2 filters and security filters protecting the main application path the end users themselves use. Only if you would like to share the same JAX-RS resource code and access URIs between end users and clients then it can become handy. More on it below.
4.3. How to get the user login name

When one writes a custom server application which needs to participate in OAuth2 flows, the major question which needs to be addressed is how one can access a user login name that was used during the end-user authorizing the third-party client. This username will help to uniquely identify the resources that the 3rd party client is now attempting to access. The following code shows one way of how this can be done:

```java
@Path("/userResource")
public class ThirdPartyAccessService {

    @Context
    private MessageContext mc;

    @GET
    public UserResource getUserResource() {
        OAuthContext oauth = mc.getContent(OAuthContext.class);
        if (oauth == null || oauth.getSubject() == null ||
                oauth.getSubject().getLogin() == null) {
            throw new WebApplicationException(403);
        }
        String userName = oauth.getSubject().getLogin();
        return findUserResource(userName);
    }

    private UserResource findUserResource(String userName) {
        // find and return UserResource
    }
}
```

The above shows a fragment of the JAX-RS service managing the access to user resources from authorized 3rd-party clients (see the Design Considerations section for more information).

The injected MessageContext provides an access to OAuthContext which has been set by OAuth2 filters described in the previous section. OAuthContext will act as a container of the information which can be useful to the custom application code which do not need to deal with the OAuth2 internals.

4.4. Client-side support

When developing a third-party application which needs to participate in OAuth2 flows one has to write the code that will redirect users to OAuth2 AuthorizationCodeGrantService, interact with AccessTokenService in order to exchange code grants for access tokens as well as correctly build Authorization OAuth2 headers when accessing the end users’ resources. JAX-RS makes it straightforward to support the redirection, while OAuthClientUtils class makes it possible to encapsulate most of the complexity away from the client application code.

For example, the following custom code can be used by the third-party application:

```java
public class OAuthClientManager {

    private WebClient accessTokenService;
    private String authorizationServiceURI;
```
private Consumer consumer;

// inject properties, register the client application...

public URI getAuthorizationServiceURI(ReservationRequest request,
URI redirectUri,
/* state */String reservationRequestKey) {
    String scope = OAuthConstants.UPDATECALENDARSCOPE + request.getHour();
    return OAuthClientUtils.getAuthorizationURI(authorizationServiceURI,
            consumer.getKey(),
            redirectUri.toString(),
            reservationRequestKey,
            scope);
}

public ClientAccessToken getAccessToken(AuthorizationCodeGrant codeGrant) {
    try {
        return OAuthClientUtils.getAccessToken(accessTokenService,
                consumer, codeGrant);
    } catch (OAuthServiceException ex) {
        return null;
    }
}

public String createAuthorizationHeader(ClientAccessToken token) {
    return OAuthClientUtils.createAuthorizationHeader(consumer,
            token);
}

The reason such a simple wrapper can be introduced is to minimize the exposure to OAuth2 of the main application code to the bare minimum, this is why in this example OAuthServiceExceptions are caught, presumably logged and null values are returned which will indicate to the main code that the request failed. Obviously, OAuthClientUtils can be used directly as well.

### 4.5. OAuth2 without Explicit Authorization

Client Credentials is one of OAuth2 grants that does not require the explicit authorization and is currently supported by CXF.

### 4.6. OAuth2 without a Browser

When an end user is accessing the 3rd party application and is authorizing it later on, it's usually expected that the user is relying on a browser. However, supporting other types of end users is easy enough. Writing the client code that processes the redirection requests from the 3rd party application and AuthorizationRequestService is simple with JAX-RS and additionally CXF can be configured to do auto-redirects on the client side.

Also note that AuthorizationRequestService can return XML or JSON OAuthAuthorizationData representations. That makes it easy for a client code to get OAuthAuthorizationData and offer a
pop-up window or get the input from the command-line. Authorizing the third-party application might even be automated in this case - which can lead to a complete 3-leg OAuth flow implemented without a human user being involved.

4.7. Controlling the Access to Resource Server

One of the most important issues one needs to resolve is how to partition a URI space of the resource server application. We have two different parties trying to access it, the end users which access the resource server to get to the resources which they own and 3rd party clients which have been authorized by the end users to access some of their resources. In the former case the way the authentication is managed is completely up to the resource server application: basic authentication, two-way TLS, OpenId (more on it below), you name it.

In the latter case an OAuth filter must enforce that the 3rd party client has been registered using the provided client key and that it has a valid access token which represents the end user's approval. It's kind of the authentication and the authorization check at the same time.

Letting both parties access the resource server via the same URI(s) complicates the life for the security filters but all the parties are only aware of the single resource server URI which all of them will use.

Providing different access points to end users and clients may significantly simplify the authentication process - the possible downside is that multiple access points need to be maintained by the resource server. Both options are discussed next.

4.7.1. Sharing the same access path between end users and clients

The first problem which needs to be addressed is how to distinguish end users from third-party clients and get both parties authenticated as required. Perhaps the simplest option is to extend a CXF OAuth2 filter (JAX-RS or servlet one), check Authorization header, if it is OAuth2 then delegate to the superclass, alternatively - proceed with authenticating the end users:

```java
public class SecurityFilter extends org.apache.cxf.rs.security.oauth2.filters.OAuthRequestFilter {
    @Context
    private HttpHeaders headers;

    public Response handleRequest(ClassResourceInfo cri, Message message) {
        String header = headers.getRequestHeaders().getFirst("Authorization");
        if (header.startsWith("Bearer ")) {
            return super.handleRequest(cri, message);
        } else {
            // authenticate the end user
        }
    }
}
```
The next issue is how to enforce that the end users can only access the resources they've been authorized to access. For example, consider the following JAX-RS resource class:

```java
@Path("calendar")
public class CalendarResource {

    @GET
    @Path("{id}")
    public Calendar getPublicCalendar(@PathParam("id") long id) {
        // return the calendar for a user identified by 'id'
    }

    @GET
    @Path("{id}/private")
    public Calendar getPrivateCalendar(@PathParam("id") long id) {
        // return the calendar for a user identified by 'id'
    }

    @PUT
    @Path("{id}")
    public void updateCalendar(@PathParam("id") long id, Calendar c) {
        // update the calendar for a user identified by 'id'
    }
}
```

Let's assume that the 3rd party client has been allowed to read the public user Calendars at "/calendar/{id}" only, how to make sure that the client won't try to:

1. update the calendar available at the same path
2. read the private Calendars available at "/calendar/{id}/private"

As noted above, OAuthPermission has an optional URIs property. Thus one way to solve the problem with the private calendar is to add, say, a uri "calendar/{id}" or "calendar/1" (etc) property to OAuthPermission (representing a scope like "readCalendar") and the OAuth filter will make sure no subresources beyond "calendar/{id}" can be accessed. Note, adding a "*" at the end of a given URI property, for example, "/a*" will let the client access "/a", "/a/b", etc.

Solving the problem with preventing the update can be easily solved by adding an httpVerb property to a given OAuthPermission.

One more option is to rely on the role-based access control and have @RolesAllowed allocated such that only users in roles like "client" or "enduser" can invoke the getCalendar() method and let only those in the "enduser" role access getPrivateCalendar() and updateCalendar(). OAuthPermission can help here too as described in the section on using OAuth filters.

### 4.7.2. Providing different access points to end users and clients

Rather than letting both the end users and 3rd party clients use the same URI such as "http://myapp.com/service/calendars/{id}" one may want to introduce two URIs, one for end users and one for third-party clients, for example, "http://myapp.com/service/calendars/{id}" - for endusers, "http://myapp.com/partners/calendars/{id}" - for the 3rd party clients and deploy 2
jaxrs endpoints, where one is protected by the security filter checking the end users, and the one
- by OAuth filters.

Additionally the endpoint managing the 3rd party clients will deploy a resource which will offer
a restricted URI space support. For example, if the application will only allow 3rd party clients to
read calendars then this resource will only have a method supporting @GET and "/calendar/\{id\}".
Chapter 5. Combining JAX-WS and JAX-RS

Starting with the JAX-RS development is not necessarily all or nothing decision. Some users may want to start developing new web services using JAX-RS while some will prefer continue building on their SOAP WS experience. Sometimes migrating the advanced SOAP services is not an option at all. CXF provides the production-quality environment for SOAP and RESTful web services be developed and combined if needed.

The real world Java-based web services projects will often combine all sort of web services, some of them written using JAX-WS and some JAX-RS. One obvious option for combining JAX-WS and JAX-RS services in CXF is to register multiple JAX-WS and JAX-RS service endpoints all referencing the same service bean. The SOAP WS and REST approaches are different but nothing prevents JAX-WS and JAX-RS service beans delegating to some shared implementation, for example, the one reading or writing data to the database.

Often enough, the SOAP developers who would like to experiment with JAX-RS or make their SOAP services more HTTP-centric, wish to reuse the same code serving both SOAP and plain HTTP requests. CXF lets do the combinataion using either the Java-First or WSDL-first approach.
Combining JAX-WS and JAX-RS

5.1. Using Java-First Approach

Combining JAX-RS and JAX-WS using the Java-First approach is about annotating the interface or concrete class with both JAX-WS and JAX-RS annotations:

```java
package server;

import javax.jws.WebMethod;
import javax.jws.WebParam;
import javax.jws.WebService;
import javax.ws.rs.Consumes;
import javax.ws.rs.GET;
import javax.ws.rs.POST;
import javax.ws.rs.Path;
import javax.ws.rs.PathParam;
import javax.ws.rs.Produces;

@WebService
@Path(”/bookstore")
@Consumes("application/xml")
@Produces("application/xml")
public interface BookStoreJaxrsJaxws {

@WebMethod
@GET
@Path("/{id}")
@Consumes("application/xml")
Book getBook(@PathParam("id") @WebParam(name = "id") Long id);

@WebMethod
@POST
@Path("/books")
Book addBook(@WebParam(name = "book") Book book);
}
```

In this example, the BookStoreJaxrsJaxws implementation class will need to be declared as a standalone bean and referenced from JAX-WS and JAX-RS endpoints. Both JAX-WS and JAX-RS proxies will be able to reuse this interface for consuming SOAP and RESTful web services. Please see the jaxrs_jaxws_java_first demo in the Talend ESB Examples distribution for a concrete example.

5.2. Using Document-First Approach

Many SOAP developers prefer a document-first (or WSDL-first) approach toward developing WS services. After a WSDL document has been created, the code generator produces the boilerplate server and possibly the client code, with the generated interface such as BookStoreJaxrsJaxws in the previous section containing the JAX-WS annotations only.

Attempting to reuse the same interface by adding JAX-RS annotations is not realistic given that the interface will be re-generated the next time the code generator runs. CXF JAX-RS provides an advanced no-annotations feature which can be used to apply the external JAX-RS like model
to a given interface or class and turn it into a RESTful resource without modifying it directly. Please check the jaxrs_jaxws_document_first demo in the Talend ESB examples distribution and see how this feature is used.
Chapter 6. Talend ESB Service Recommended Project Structure

Developers are encouraged, whenever feasible, to have the following project structure for developing JAX-WS and JAX-RS applications:

<table>
<thead>
<tr>
<th>Folder</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>client</td>
<td>Provides the client for interacting with the deployed service. Usually activated by navigating to this folder and entering <code>mvn exec:java</code> (see the README file for the particular project for any project-specific information.)</td>
</tr>
<tr>
<td>common</td>
<td>Consists of common resource classes, JAXB objects, and any other objects usable by both the client and service modules.</td>
</tr>
<tr>
<td>service</td>
<td>Provides the service implementation code. Used both by the war project for servlet deployment and as an OSGi bundle for the Talend Runtime container.</td>
</tr>
<tr>
<td>war</td>
<td>Provides a deployable WAR that can be used with servlet containers such as Jetty or Tomcat. Consists mainly of the web.xml and Spring beans.xml file indicating resources and providers that need loading. The Talend Runtime container does not need this module.</td>
</tr>
</tbody>
</table>
Chapter 7. Talend ESB Service Examples

The samples folder of the Talend ESB download contain examples that are provided by the Apache CXF project, as well as Talend ESB-specific examples showing multiple usages of JAX-RS, JMS, Security and CXF interceptors. Each Talend ESB sample has its own README file providing a full description of the sample along with deployment information using embedded Jetty or Talend Runtime container.

The examples provided by the Apache CXF project and bundled with the Talend ESB are listed and summarized on the CXF website; the below listing provides a summary of additional CXF examples provided in the Talend ESB distribution.

<table>
<thead>
<tr>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>jaxws-cxf-sts</td>
<td>Demonstrates having a SOAP client use CXF’s stscclient to make a call to a</td>
</tr>
<tr>
<td></td>
<td>Tomcat-hosted CXF Security Token Service (STS) and subsequently using</td>
</tr>
<tr>
<td></td>
<td>the SAML token received to make a web service call to a CXF web service</td>
</tr>
<tr>
<td></td>
<td>provider. Both standalone and OSGi-based clients are shown, as well as</td>
</tr>
<tr>
<td></td>
<td>standalone, Tomcat-based, and OSGi-based web service provider options</td>
</tr>
<tr>
<td></td>
<td>given.</td>
</tr>
<tr>
<td>jaxws-cxf-sts-advanced</td>
<td>More advanced version of the above showing OSGi deployment of the</td>
</tr>
<tr>
<td></td>
<td>STS, token providers, token validation, and WSP authorization based on</td>
</tr>
<tr>
<td></td>
<td>attributes within the SAML token.</td>
</tr>
<tr>
<td>jaxws-ws-secpol</td>
<td>Demonstrates using WS-SecurityPolicy and configuration to secure</td>
</tr>
<tr>
<td></td>
<td>communication between CXF client and servers using various security</td>
</tr>
<tr>
<td></td>
<td>requirements and including tokens like UsernameToken and SAML assertions.</td>
</tr>
<tr>
<td>jaxws-jms-spec</td>
<td>Demonstrates using JAX-WS clients and servers to talk SOAP over JMS, but</td>
</tr>
<tr>
<td></td>
<td>using the SOAP/JMS Specification for configuration.</td>
</tr>
<tr>
<td>interceptors</td>
<td>Demonstrates how a message changes and is manipulated as it passes</td>
</tr>
<tr>
<td></td>
<td>through the various CXF interceptors.</td>
</tr>
<tr>
<td>jaxrs-intro</td>
<td>Shows basic features of the the JAX-RS 1.1 specification and API such as</td>
</tr>
<tr>
<td></td>
<td>root resources, subresources and HTTP verbs (GET/PUT/POST).</td>
</tr>
<tr>
<td>jaxrs-advanced</td>
<td>Building on the jaxrs-intro sample, this demo additionally demonstrates</td>
</tr>
<tr>
<td></td>
<td>multiple root resource classes, recursive subresources, resource methods</td>
</tr>
<tr>
<td></td>
<td>consuming and producing data in different formats (XML and JSON), using</td>
</tr>
<tr>
<td></td>
<td>JAX-RS Response to return status, headers and optional entity, using</td>
</tr>
<tr>
<td></td>
<td>UriInfo and UriBuilder for working with URI and ExceptionMappers for handling</td>
</tr>
<tr>
<td></td>
<td>application exceptions.</td>
</tr>
<tr>
<td>jaxrs-attachments</td>
<td>Demonstrates how JAX-RS consumers and providers can read and write</td>
</tr>
<tr>
<td></td>
<td>multipart attachments.</td>
</tr>
<tr>
<td>jaxrs-jaxws-authorization</td>
<td>Shows how a Role-Base-Access-Control policy can be applied to JAX-WS</td>
</tr>
<tr>
<td></td>
<td>and JAX-RS services with the help of the container-managed authentication</td>
</tr>
<tr>
<td></td>
<td>and CXF security filters enforcing the authorization rules.</td>
</tr>
<tr>
<td>jaxrs-jaxws-description-first</td>
<td>Shows how SOAP services created as part of the document (WSDL) first</td>
</tr>
<tr>
<td></td>
<td>approach process can get RESTified by having a CXF JAX-RS user model</td>
</tr>
<tr>
<td></td>
<td>resource added which describes how an interface generated by the wsdl-</td>
</tr>
<tr>
<td></td>
<td>to-java tool can be treated as the JAX-RS root resource.</td>
</tr>
<tr>
<td>jaxrs-jaxws-java-first</td>
<td>Shows how a single service instance can be exposed as both JAX-RS and</td>
</tr>
<tr>
<td></td>
<td>JAX-WS services at the same time and how CXF JAX-RS and JAX-WS proxies</td>
</tr>
<tr>
<td></td>
<td>can reuse the same code for invoking on the corresponding endpoints.</td>
</tr>
<tr>
<td>jaxrs-jms-http</td>
<td>Demonstrates how a JAX-RS HTTP server can be enhanced to receive JMS</td>
</tr>
<tr>
<td></td>
<td>messages.</td>
</tr>
<tr>
<td>Example</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>jaxrs-oauth</td>
<td>Provides an example of a REST application protected using OAuth security.</td>
</tr>
<tr>
<td>jaxrs-attachments</td>
<td>Demonstrates how JAX-RS providers and consumers read and write XOP and regular multipart/mixed attachments</td>
</tr>
<tr>
<td>jaxrs-transformations</td>
<td>Demonstrates how CXF can help with maintaining backward and forward compatibility between JAX-RS and JAX-WS consumers and endpoints by using the Transformation Feature of CXF.</td>
</tr>
</tbody>
</table>
Chapter 8. Configuring JMX Integration

To enable JMX integration, register an InstrumentationManager extension with the CXF bus. Using Spring XML on Tomcat, the following minimal XML snippet will enable JMX integration.

```xml
<import resource="classpath:META-INF/cxf/cxf.xml"/>
...
<br:bean id="org.apache.cxf.management.InstrumentationManager"
    class="org.apache.cxf.management.jmx.InstrumentationManagerImpl">
    <br:property name="enabled" value="true"/>
    <br:property name="bus" ref="cxf"/>
    <br:property name="usePlatformMBeanServer" value="true"/>
</br:bean>
```

The default InstrumentationManager accepts the following configuration options:

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>enabled</td>
<td>If the JMX integration should be enabled or not</td>
<td>false</td>
</tr>
<tr>
<td>bus</td>
<td>The CXF bus instance to register the JMX extension with</td>
<td>None</td>
</tr>
<tr>
<td>server</td>
<td>An optional reference to an MBeanServer instance to register MBeans with. If not supplied, an MBeanServer is resolved using the &quot;usePlatformMBeanServer&quot; and/or 'serverName' options.</td>
<td>None</td>
</tr>
<tr>
<td>usePlatformMBeanServer</td>
<td>If true and no reference to an MBeanServer is supplied, the JMX extension registers MBeans with the platform MBean server.</td>
<td>false</td>
</tr>
<tr>
<td>serverName</td>
<td>If supplied, usePlatformMBeanServer is false, and no reference to an MBeanServer is supplied, the JMX extension registers MBeans with the MBean server carrying this name.</td>
<td>None</td>
</tr>
<tr>
<td>createMBeanServerConnectorFactory</td>
<td>If true, a connector is created on the MBeanServer.</td>
<td>true</td>
</tr>
<tr>
<td>threaded</td>
<td>Determines if the creation of the MBean connector is performed in this thread or in a separate thread. Only relevant if createMBeanServerConnectorFactory is true.</td>
<td>false</td>
</tr>
<tr>
<td>daemon</td>
<td>Determines if the MBean connector creation thread is marked as a daemon thread or not. Only relevant if createMBeanServerConnectorFactory is true.</td>
<td>false</td>
</tr>
<tr>
<td>JMXServiceURL</td>
<td>The URL of the connector to create on the MBeanServer. Only relevant if createMBeanServerConnectorFactory is true.</td>
<td>service:jmx:rmi:///jndi/rmi://localhost:9913/jmxrmi</td>
</tr>
</tbody>
</table>

The MBean instrumentation provided by the above configuration will provide generic information about the WSDL supported by the web service as well as web service administration commands. To see performance metrics of the SOAP call processing, further configuration (see [http://cxf.apache.org/docs/jmx-management.html](http://cxf.apache.org/docs/jmx-management.html)) is required - these are disabled by default to avoid unnecessary runtime overhead.

If you’re using Maven, make sure you have the following dependency added to the pom.xml for the web service provider:

```xml
<dependency>
    <groupId>org.apache.cxf</groupId>
```
<artifactId>cxf-rt-management</artifactId>
<version>${cxf.version}</version>
</dependency>
8.1. Example Configuration

Enable JMX integration by adding the following XML to your CXF Spring context:

```xml
<bean id="org.apache.cxf.management.InstrumentationManager"
     class="org.apache.cxf.management.jmx.InstrumentationManagerImpl">
     <property name="bus" ref="cxf"/>
     <property name="enabled" value="true"/>
     <property name="JMXServiceURL" value="service:jmx:rmi:///jndi/rmi://localhost:9914/jmxrmi"/>
</bean>
```

An equivalent configuration of the above instrumentation manager can be directly made within the bus configuration using the corresponding property names having the "bus.jmx" prefix, as in:

```xml
<cxf:bus bus="cxf">
    <cxf:properties>
        <entry key="bus.jmx.enabled" value="true"/>
        <entry key="bus.jmx.JMXServiceURL" value="service:jmx:rmi:///jndi/rmi://localhost:9914/jmxrmi"/>
    </cxf:properties>
</cxf:bus>
```

From CXF 2.5.x onwards, if a MBeanServer is available in the Spring context or as an OSGi server (when running in OSGi), the InstrumentationManager will be automatically enabled and will use that MBeanServer and the CXF MBeans will be registered. Therefore, the instrumentation manager configuration shown above is not needed in such cases.

To test the configuration start up your service and connect to it by using JConsole from the JDK.

Then you can browse to your endpoint:
8.2. How to get web service performance metrics

These metrics include Request/Response time, number of calls, and so on.

The CXF management module also provides a feature (the MetricsFeature) which provides aggregate statistics for services running in the CXF Bus. It is not enabled by default to avoid unnecessary runtime overhead during web service call processing, but it needs to be added as JAX-WS feature.

Here is the configuration snippet that you should add to your Spring context file to be able to view this information:

```xml
<jaxws:endpoint id="my-service" implementor="ex.example.MyServiceImpl" address="/myService">
  <jaxws:features>
    <bean class="org.apache.cxf.metrics.MetricsFeature"/>
  </jaxws:features>
</jaxws:endpoint>
```

When using Maven for build, the following dependency need to be added to the Maven POM:

```xml
<dependency>
  <groupId>org.apache.cxf</groupId>
  <artifactId>cxf-rt-features-metrics</artifactId>
  <version>${cxf.version}</version>
</dependency>
```

In WAR deployments, this additional dependency must also be declared:

```xml
<dependency>
  <groupId>io.dropwizard.metrics</groupId>
  <artifactId>metrix-core</artifactId>
  <version>${dropwizard.metrics.version}</version>
</dependency>
```
The MetricsFeature collects the following metrics: invocations, checked application faults, unchecked application faults, runtime faults, logical runtime faults, mean handling time, max handling time, and min handling time. Note a SOAP call will need to occur against the web service before you will see the MBean within your JMX monitoring software.
Chapter 9. Communication styles

Talend ESB supports several communication styles, including Request-Response, One-way, Request-Callback and Notification. Request-Response and One-way supports both HTTP/HTTPS and SOAP/JMS, whereas Request-Callback and Notification only supports SOAP over JMS.

For more information on the different communication styles, see the following sections:

- Request-Response
- One-way
- Request-Callback
- Notification

For more information about the configuration of SOAP/JMS for Talend ESB, see Configuring SOAP over JMS.

And for a real use case of the different communication styles, refer to the Library example provided with the Talend Runtime, under the examples/talend/tesb/library-service directory. For more information about how to run this use case, see the README files provided with the example.
9.1. Request-Response

The Request-Response communication style used in Talend ESB is the standard Request-Response Message Exchange Pattern. It is based on the REST Service Response communication, and supports HTTP and HTTPS (for the Data services developed in the Talend Studio) and SOAP JMS for JAVA (Jax-WS) ESB Consumer and Providers only.

9.2. One-way

The One-way communication style used in Talend ESB is the standard Web service One-way Message Exchange Pattern. It supports HTTP and HTTPS (for the Data services developed in the Talend Studio) and SOAP JMS for JAVA (Jax-WS) ESB Consumer and Providers only.

9.3. Request-Callback

When a consumer sends a request to a provider, the consumer normally waits for the response to return before it can continue with its work. In cases where the response returns immediately, a request-response message exchange pattern is sufficient. But there can be scenarios when request processing can be delayed by few hours or even days. In such cases, it is useful for the consumer to be able to continue its work and handle the response later. The Request-Callback message exchange pattern supports exactly this scenario. The consumer can continue its processing without interruptions and is notified when the response is returned at a later point in time.

9.3.1. WSDL for Request-Callback Message Exchange

The Request-Callback message exchange is described in WSDL as two separate one-way exchanges.

The WSDL starts with a “Types” section followed by “message definitions”. Additionally, it contains two “portType” definitions - one for the request from the consumer to the provider (Library) and
one for the response from the provider (**LibraryConsumer**). The second callback portType contains two operations - one for a regular callback response and one for a callback fault response. Both operations (in **LibraryConsumer**) declare the Library portType operation as a "partnerOperation" element.

The WSDL used in this message exchange pattern additionally has a "partnerLink" definition, which declares the first portType (**Library**) as a "service" and the second (**LibraryConsumer**) as a "callback".

In the following WSDL, the request operation is called **seekBookInBasement** and that callback operation is called **seekBookInBasementResponse**:

**Example of WSDL with request-callback exchange**

```xml
<?xml version="1.0" encoding="UTF-8"?>
<definitions

targetNamespace="http://services.talend.org/demos/Library/1.0"

xmlns="http://schemas.xmlsoap.org/wsdl/"
xmlns:jms="http://schemas.xmlsoap.org/wsdl/jms/"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:svn="http://types.talend.org/demos/Library/Common/1.0"
xmlns:tns="http://services.talend.org/demos/Library/1.0"
xmlns:tme="http://types.talend.com/mep/1.0"
xmlns:types="http://types.talend.org/service/ServiceDescription/2.0"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">

<message name="seekBookRequest">
    <part element="svn:SearchFor" name="body" />
</message>

<message name="seekBookInBasementRequest">
    <part element="svn:SearchInBasementFor" name="body" />
</message>

<message name="seekBookResponse">
    <part element="svn:ListOfBooks" name="body" />
</message>

<message name="seekBookError">
    <part element="err:Exceptions" name="Exception" />
</message>

<portType name="Library">

    <operation name="seekBook">
        <input message="tns:seekBookRequest" />
        <output message="tns:seekBookResponse" />
        <fault message="tns:seekBookError" name="error" />
    </operation>

    <operation name="seekBookInBasement">
        <input message="tns:seekBookInBasementRequest" />
    </operation>
</portType>

<portType name="LibraryConsumer">

    <operation name="seekBookInBasementResponse"
        sdx:partnerOperation="seekBookInBasement">

```
<input message="tns:seekBookResponse" />
</operation>
<operation name="seekBookInBasementFault"
  sdx:faultOperation="true" sdx:partnerOperation="seekBookInBasement">
  <input message="tns:seekBookError" />
</operation>
</portType>

<plnk:partnerLinkType name="CallbackPartnerLink"
  xmlns:plnk="http://schemas.xmlsoap.org/ws/2003/05/partner-link/">
  <plnk:role name="service">
    <plnk:portType name="tns:Library" />
  </plnk:role>
  <plnk:role name="callback">
    <plnk:portType name="tns:LibraryConsumer" />
  </plnk:role>
</plnk:partnerLinkType>

<service name="LibraryProvider">
  <port binding="tns:LibraryJmsSoap" name="LibraryJmsPort">
    <soap:address
      location="jms:jndi:dynamicQueues/library.queue?
jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory&jnd
iConnectionFactoryName=ConnectionFactory&jndiURL=tcp://localhost:61616" />
  </port>
</service>

<binding name="LibraryJmsSoap" type="tns:Library">
  <soap:binding style="document"
    transport="http://www.w3.org/2010/soapjms" />
  <operation name="seekBook">
    <soap:operation soapAction="seekBook" />
    <input>
      <soap:body use="literal" />
    </input>
  </operation>
  <operation name="seekBookInBasement">
    <soap:operation soapAction="seekBookInBasement" />
    <input>
      <soap:body use="literal" />
    </input>
  </operation>
</binding>

<service name="LibraryConsumer">
  <port binding="tns:LibraryConsumerJmsSoap" name="LibraryConsumerPort">
    <soap:address
      location="jms:jndi:dynamicQueues/libraryconsumer.queue?
jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory&jnd
iConnectionFactoryName=ConnectionFactory&jndiURL=tcp://localhost:61616" />
  </port>
</service>
The **LibraryConsumer** service waits for callback responses from the service provider (listening to the ActiveMQ queue). The operations involved in the message exchange are: `seekBookInBasement`, `seekBookInBasementResponse` and `seekBookInBasementFault`.

### 9.3.2. Relation between Request and Callback Messages

The relationship between a request sent and a response received is achieved by adding a special `callId` header to both request and callback messages:

#### For this Request message

```xml
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/">
  <soap:Header>
    <callId xmlns="http://www.talend.com/esb/requestcallback">urn:uuid:8b64f8f3-d72b-4a6f-a206-8a3309920998</callId>
    <MessageID xmlns="http://www.w3.org/2005/08/addressing">urn:uuid:1d1dce72-66b3-4c47-aebe-dd462b1e5d32</MessageID>
    <To xmlns="http://www.w3.org/2005/08/addressing">http://localhost:9090/tesb-library-tutorial/services/LibraryProvider</To>
    <ReplyTo xmlns="http://www.w3.org/2005/08/addressing">
      <Address>http://consumer.example.com:7777/soap/LibraryConsumer</Address>
    </ReplyTo>
    <RelatesTo xmlns="http://www.w3.org/2005/08/addressing" RelationshipType="message"/>
  </soap:Header>
  <soap:Body>
  <!-- some data here -->
  </soap:Body>
</soap:Envelope>
```

The response for this message may look like the following:

**Corresponding Callback response**
9.3.3. Defining Participants

Participants for the request-callback message exchange can be done in two ways: using the CXF API or using Spring-based configuration. It is possible to use org.talend.esb.mep.requestcallback.feature.CallContext methods for the participant setup.

9.3.3.1. Updating the Service Provider

The Provider side setup includes creating a Provider service (that receives the request from the consumer) and a callback client that will send the callback response to the consumer. The following is an example of a provider side service Spring configuration:

Provider side service Spring configuration

```
<jaxws:endpoint xmlns:library="http://services.talend.org/demos/Library/1.0"
    id="LibraryProviderJMS"
    address="/dynamicQueues/library.queue?
    jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory
    &jndiConnectionFactoryName=ConnectionFactory&jndiURL=tcp://localhost:61616"
    serviceName="library:LibraryProvider" endpointName="library:LibraryJmsPort"
    implementor="#libraryServerImpl">
    <jaxws:features>
        <bean
class="org.talend.esb.mep.requestcallback.feature.RequestCallbackFeature"/>
        <bean class="org.apache.cxf.feature.LoggingFeature"/>
    </jaxws:features>
</jaxws:endpoint>
```

RequestCallbackFeature feature should be added to the service to allow request-callback functionality.
Service Provider Implementation

The service provider implementation may be done using JAX-WS. In such case, the provider side
method in the annotated interface may look like this:

Library JAX-WS annotated interface

```java
@WebService(targetNamespace = "http://services.talend.org/demos/Library/1.0",
            name = "Library")
@XmlSeeAlso({org.talend.types.demos.library.common._1.ObjectFactory.class,
            org.talend.types.demos.generalobjects.errorhandling._1.ObjectFactory.class})
public interface Library {
...
    @SOAPBinding(parameterStyle = SOAPBinding.ParameterStyle.BARE)
    @Oneway
    @WebMethod(action = "seekBookInBasement")
    public void seekBookInBasement(
            @WebParam(partName = "body", name = "SearchInBasementFor",
                       targetNamespace = "http://types.talend.org/demos/Library/
                      Common/1.0")
            org.talend.types.demos.library.common._1.SearchInBasementFor body
    );
    ...
}
```

A JAX-WS client must be created on the provider side to send a callback because the callback
message is sent to a separate endpoint opened on the consumer side. The Client object may be
set up as a `jaxws:client` bean in Spring configuration.

Provider side jaxws:client configuration example

```xml
<jaxws:client xmlns:library="http://services.talend.org/demos/Library/1.0"
              id="callbackResponseClient" serviceName="library:LibraryConsumer"
              endpointName="library:LibraryConsumerPort" address="jms://"
              serviceClass="org.talend.services.demos.library._1_0.LibraryConsumer">
    <jaxws:features>
        <bean class="org.apache.cxf.feature.LoggingFeature"/>
    </jaxws:features>
</jaxws:client>
```

The Client needs the Talend ESB CallContext feature to be set up as well as a service provider
to work properly. `CallContext` class has a method that helps to set up callback proxy object. The
method is called `setupCallbackProxy` and after it was applied to the proxy object, the proxy is
ready to work.

Each request-callback message has a call context object associated with it. Call context is
necessary for proper handling of request-callback messages. Call context object contains such
information as call id, callback id, address of endpoint to which reply should be sent, and so on.
The class `org.talend.esb.mep.requestcallback.feature.CallContext` is used to represent call context
objects. It is necessary to extract call context from a message when handling request, at least to
provide call id of the message to which callback message is related to.

In the example above, the callback proxy object was injected into the service provider and the
callback was sent from the same thread in which request was received. In real-world scenarios,
it is a rare situation, it is here just for the example purpose.

The request-callback processing on the provider side is shown below:
Request-Callback processing on provider side example

```java
public class LibraryServerImpl implements Library {
    ...
    // Injected jaxws:client (see xml config above)
    private LibraryConsumer callbackResponseClient;

    @Resource
    private WebServiceContext wsContext;

    @Override
    public void seekBookInBasement(SearchInBasementFor body) {
        // Extract call context from message
        CallContext ctx = CallContext.getCallContext(wsContext.getMessageContext());

        // Some business logic here
        ListOfBooks result = new ListOfBooks();
        BookType book = new BookType();
        result.getBook().add(book);
        PersonType author = new PersonType();
        book.getAuthor().add(author);
        author.setFirstName("John");
        author.setLastName("Stripycat");
        Calendar dateOfBirth = new GregorianCalendar(202, Calendar.MAY, 17);
        author.setDateOfBirth(dateOfBirth.getTime());
        book.getTitle().add("Hunting basement inhabitants");
        book.getPublisher().add("Dusty Edition");
        book.setYearPublished("2013");

        // Set up necessary interceptors for callback proxy object
        ctx.setupCallbackProxy(callbackResponseClient);

        // Send callback message back to client
        callbackResponseClient.seekBookInBasementResponse(result);
    }

    ...
}
```

9.3.3.2. Updating the Service Consumer

The consumer side configuration includes setting up a CXF client to send a request to the provider, and setting up a CXF endpoint which will receive callback messages back from the provider. The client may be set up using Spring-based configuration. `RequestCallbackFeature` must be added to the client to work properly. The following is an example of Client Spring configuration:

**CXF client configuration on consumer side**

```xml
<jaxws:client id="library" serviceName="library:LibraryProvider"
    endpointName="library:LibraryJmsPort"
    address="jms:jndi:dynamicQueues/library.queue?jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory&jndiConnectionFactoryName=ConnectionFactory&jndiURL=tcp://localhost:61616" serviceClass="org.talend.services.demos.library._1_0.Library">
    <jaxws:features>
```

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The setup of callback-receiving endpoint on the consumer side can be done via Spring configuration as well:

**Callback-receiving endpoint Spring configuration**

```xml
<jaxws:endpoint xmlns:library="http://services.talend.org/demos/Library/1.0"
                id="LibraryConsumerJMS"
                address="jms:jndi:dynamicQueues/libraryconsumer.queue?
                serviceName="library:LibraryConsumer"
                endpointName="library:LibraryConsumerPort"
                implementor="org.talend.services.demos.client.LibraryConsumerImpl">
    ...
    <jaxws:features>
        <bean class="org.talend.esb.mep.requestcallback.feature.RequestCallbackFeature" />
        <bean class="org.apache.cxf.feature.LoggingFeature" />
    </jaxws:features>
    <jaxws:properties>
        <entry key="jaxws.provider.interpretNullAsOneway" value="true"/>
    </jaxws:properties>
</jaxws:endpoint>
```

After both provider and consumer are set up, the request-callback message exchange can be done. The following is an example of sending a request:

**Sending request from consumer to provider**

```java
public class LibraryTester {
    ...

    /** The Library proxy will be injected either by spring or by a direct call 
     * to the setter */
    Library library;

    public void testRequestCallbackPositive() throws SeekBookError {
        // Create new request object and fill it with 
        // some business data
        SearchInBasementFor request = new SearchInBasementFor();
        request.getAuthorLastName().add("Stripycat");

        // Add correlation info map to the request context
        Map<String, Object> rctx = ((BindingProvider) library).getRequestContext();
        Map<String, Object> correlationInfo = new HashMap<String, Object>();
        rctx.put(RequestCallbackFeature.CALL_INFO_PROPERTY_NAME,
                 correlationInfo);

        // Send request to the provider
        library.seekBookInBasement(request);
    }
    ...
```
**CallContext** object related to request-callback messages contains various information regarding a message. The following code snippet shows how to get the message information on the consumer side when callback message is received.

### Receiving callback message

```java
@WebServiceProvider
@Features(features =
  { "org.talend.esb.mep.requestcallback.feature.RequestCallbackFeature"})
public class LibraryConsumerImpl implements LibraryConsumer {
    @Resource
    private WebServiceContext wsContext;
    public void seekBookInBasementResponse(ListOfBooks body) {
        CallContext ctx =
            CallContext.getCallContext(wsContext.getMessageContext());
        System.out.println("Info from CallContext:");
        if (ctx == null) {
            System.out.println("- no CallContext");
        } else {
            System.out.println("- Call ID is " + ctx.getCallId());
            System.out.println("- Callback ID is " + ctx.getCallbackId());
        }
    }
    ...
}
```

### 9.3.4. Project dependencies

To be able to work with the Request-Callback message exchange, the request-callback dependency should be added:

#### Request-Callback message exchange pattern dependency

```xml
<dependency>
    <groupId>org.talend.esb.mep</groupId>
    <artifactId>request-callback</artifactId>
    <version>${project.version}</version>
</dependency>
<dependency>
    <groupId>org.talend.esb</groupId>
    <artifactId>transport-jms</artifactId>
    <version>${project.version}</version>
</dependency>
```

And the CXF dependencies should be added as well:

#### CXF dependencies

```xml
<dependency>
    <groupId>org.apache.cxf</groupId>
    <artifactId>cxf-rt-frontend-jaxws</artifactId>
    <version>${cxf.version}</version>
</dependency>
<dependency>
    <groupId>org.apache.cxf</groupId>
```
To be able to configure CXF endpoints/client via Spring DI, the Spring framework dependency should be added:

**Spring framework dependency**

To implement Notification in Talend ESB, the Notification Message Exchange Pattern has been implemented using CXF, by setting up a CXF service on the consumer side and CXF service proxy on the provider side.

This following figure represents the Notification Message Exchange Pattern:
9.4.1. WSDL for Notification Message Exchange

In this message exchange, a service provider sends a message to a consumer, without expecting a reply. The service operation must only contain an output message, and the input message is not defined.

The operation in the WSDL looks like the following:

```xml
<portType name="Library">
    ....
    <operation name="newBooks" tcp:mp="notification">
        <input message="tns:newBooksNotification" />
    </operation>
</portType>

<binding name="LibraryNotificationJmsSoap" type="tns:Library">
    <soap:binding style="document" transport="http://www.w3.org/2010/soapjms/" />
    <operation name="newBooks">
        <soap:operation soapAction="newBooks" />
        <input>
            <soap:body use="literal" />
        </input>
    </operation>
</binding>
```

In this case, the provider is the initiator of the communication (it sends the messages), and the consumer is recipient of the messages.

9.4.2. Dependencies and Code Generation

The following dependencies should be added to the project to enable notification functionality:

In the pom.xml file of the project:

```xml
<dependencies>
    <!-- TESB -->
    <dependency>
        <groupId>org.talend.esb</groupId>
        <artifactId>transport-jms</artifactId>
        <version>${tesb.version}</version>
    </dependency>
    <!-- CXF -->
    <dependency>
        <groupId>org.apache.cxf</groupId>
        <artifactId>cxf-rt-frontend-jaxws</artifactId>
        <version>${cxf.version}</version>
    </dependency>
    <dependency>
        <groupId>org.apache.cxf</groupId>
        <artifactId>cxf-rt-transports-http</artifactId>
        <version>${cxf.version}</version>
    </dependency>
    <dependency>
        <groupId>org.apache.cxf</groupId>
        <artifactId>cxf-rt-ws-security</artifactId>
```
The following plugin must be added to the Maven build cycle to include the CXF code generator:

**CXF code generation plugin**

```xml
<plugins>
  <plugin>
    <groupId>org.apache.cxf</groupId>
    <artifactId>cxf-codegen-plugin</artifactId>
    <version>${cxf.version}</version>
    <executions>
      <execution>
        <id>generate-sources</id>
        <phase>generate-sources</phase>
        <configuration>
          <wsdlOptions>
            <wsdl>src/main/sr-resources/Library.wsdl</wsdl>
            <frontend>jaxws21</frontend>
            <faultSerialVersionUID>1</faultSerialVersionUID>
            <bindingFiles>
              <bindingFile>src/main/sr-resources/binding.xml</bindingFile>
            </bindingFiles>
          </wsdlOptions>
        </configuration>
        <goals>
          <goal>wsdl2java</goal>
        </goals>
      </execution>
    </executions>
  </plugin>
</plugins>
```
### 9.4.3. Setting up the Service Provider

A CXF client should be set up on the provider side to send messages to the consumer.

**Spring-based client set up via Spring**

```xml
<?xml version="1.0" encoding="UTF-8"?><!-- CXF 3 JMS configuration style -->
<import resource="classpath:/META-INF/cxf/cxf.xml"></import>
<!-- CXF client that sends notifications -->
<jaxws:client xmlns:library="http://services.talend.org/demos/Library/1.0" xmlns:jaxws="http://cxf.apache.org/jaxws"
    id="libraryPublisher" serviceName="library:LibraryProvider"
    endpointName="library:LibraryTopicPort"
    address="jms:jndi-topic:dynamicTopics/newBooksTopic.topic?
         jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory&
         jndiConnectionFactoryName=ConnectionFactory&jndiURL=tcp://localhost:61616"
    serviceClass="org.talend.services.demos.library._1_0.Library">
    <jaxws:features>
        <bean class="org.apache.cxf.ws.addressing.WSAddressingFeature"/>
        <jaxws:features>
            <bean id="libraryPublisher"
                 class="org.talend.services.demos.server.LibraryPublisher">
                <property name="library" ref="libraryPublisher"/>
            </bean>
        </jaxws:features>
    </jaxws:features>
</jaxws:client>
</beans>
```

Here is an example of how notification-sending method in `LibraryPublisher` class may be implemented:

**Notification sender**

```java
public class LibraryPublisher {
    /** The Library proxy will be injected either by spring or by a direct call to the setter */
```
Here, the `library` object is injected via Spring.

### 9.4.4. Setting up the Service Consumer

The CXF endpoint that listens for notifications should be defined on the consumer side. Here is how it looks like in Spring configuration file:

#### Setting up consumer side

```xml
<?xml version="1.0" encoding="UTF-8"?>

<beans xmlns="http://www.springframework.org/schema/beans"
    www.springframework.org/schema/context"
    core"
    services.talend.org/demos/Library/1.0"
    www.springframework.org/schema/beans/spring-beans.xsd
    www.springframework.org/schema/context/spring-context.xsd

    <import resource="classpath:META-INF/cxf/cxf.xml" />

    <!-- CXF 3 JMS configuration style -->
    <import resource="classpath:META-INF/tesb/tesb-cxf-transport-jms.xml" />
```

Communication styles
The following is an example of the implementation of the notification-receiving service:

**Consumer side notification receiver**

```java
@WebServiceProvider
public class LibraryNotificationReceiverImpl implements Library {
    @Resource
    private WebServiceContext wsContext;
    ...

    @Override
    public void newBooks(Date listDate, List<BookType> book) {
        System.out.println("****************************************************");
        System.out.println("*** newBooks notification is received");
        System.out.println("****************************************************");

        System.out.println("New books notification:");
        // Business logic here
    }
}
```
Chapter 10. Configuring SOAP over JMS

The JMS Transport is a good alternative messaging mechanism to SOAP over HTTP, as it offers a more reliable and scalable messaging support. The greater efficiency derives from the fact that JMS transports and stores Web service request and response messages in a queue until they can be processed by the server, and the client frees up threads and other resources on both systems. A Web service configured to use the JMS transport communicates with its client through a JMS queue. The client sends a SOAP message to the queue and waits for a response message on a temporary queue created just for the JMS session. The Web service processes the message and sends the response back to the temporary queue. The Java code for the client and service does not change when SOAP over JMS is configured as the transport protocol. The difference between using these protocols is apparent in how the Web service endpoints are defined.

Talend ESB supports the SOAP over JMS transport for ESB Consumers and Providers developed in JAVA (JAX-WS). The configuration in Talend ESB is primarily based on a URI-style SOAP over JMS address. For more information on the supported JMS Broker for SOAP over JMS, see the Talend Installation Guide.
10.1. URI-style SOAP over JMS configuration

To use SOAP over JMS with Talend ESB, the following dependency should be added to the service:

```xml
<dependency>
  <groupId>org.talend.esb</groupId>
  <artifactId>transport-jms</artifactId>
  <version>${project.version}</version>
</dependency>
```

After adding the dependency, it is possible to configure CXF with URI-style SOAP over JMS addresses. This dependency is optional.

Example of URI-style SOAP over JMS configuration

```xml
<jaxws:endpoint xmlns:library="http://services.talend.org/demos/Library/1.0"
  id="LibraryNotificationReceiver" address="jms:jndi-topic:dynamicTopics/newBooksTopic.topic?
  jndiInitialContextFactory=org.apache.activemq.jndi.ActiveMQInitialContextFactory&amp;
  jndiConnectionFactoryName=ConnectionFactory&amp;jndiURL=tcp://localhost:61616"
  serviceName="library:LibraryProvider" endpointName="library:LibraryTopicPort"
  implementor="org.talend.services.demos.client.LibraryNotificationReceiverImpl">
  <jaxws:features>
    <bean class="org.apache.cxf.ws.addressing.WSAddressingFeature"/>
  </jaxws:features>
</jaxws:endpoint>
```

For more information, see URI structure.

10.2. URI structure

Basically, the URI structure of a SOAP over JMS address looks like the following structure:

```xml
.jms:<variant>:<destination_name>?
jndiInitialContextFactory=<context_factory_class_name>&jndiConnectionFactoryName=<connection_factory_name>&jndiURL=<JMS_broker_URL>
```

Where:

- **variant** can have the following values:

<table>
<thead>
<tr>
<th>Variant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>jndi</td>
<td>Destination name is a jndi queue name</td>
</tr>
<tr>
<td>jndi-topic</td>
<td>Destination name is a jndi topic name</td>
</tr>
<tr>
<td>queue</td>
<td>Destination is a queue name resolved using JMS</td>
</tr>
</tbody>
</table>
Configuring SOAP over JMS

<table>
<thead>
<tr>
<th>Variant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>topic</td>
<td>Destination is a topic name resolved using JMS</td>
</tr>
</tbody>
</table>

- **destination_name** is basically the queue or topic name.

- **context_factory_class_name** is the class name of a JNDI context factory which will be used to resolve a factory which creates connections to the broker.

- **connection_factory_name** is a platform-specific connection factory name (differs for Active MQ and Websphere MQ)

- **JMS_broker_URL** is a URL which will be used by the context resolve or create connection factory and destination objects.

But CXF provides the possibility to specify further JMS parameters:

<table>
<thead>
<tr>
<th>Query Parameter</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>conduitIdSelectorPrefix</td>
<td></td>
<td>If set then this string will be the prefix for all correlation ids the conduit creates and also be used in the selector for listening to replies</td>
</tr>
<tr>
<td>deliveryMode</td>
<td>PERSISTENT</td>
<td>NON_PERSISTENT messages will kept only in memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PERSISTENT messages will be saved to disk</td>
</tr>
<tr>
<td>durableSubscriptionClientId</td>
<td></td>
<td>Optional Client identifier for the connection. The purpose is to associate a connection with a state maintained on behalf of the client by a provider. The only such state identified by the JMS API is that required to support durable subscriptions.</td>
</tr>
<tr>
<td>durableSubscriptionName</td>
<td></td>
<td>Specifies the name used to register a durable subscription.</td>
</tr>
<tr>
<td>jndiConnectionFactoryName</td>
<td>ConnectionFactory</td>
<td>Specifies the JNDI name bound to the JMS connection factory to use when connecting to the JMS destination.</td>
</tr>
<tr>
<td>jndiInitialContextFactory</td>
<td></td>
<td>Specifies the fully qualified Java class name of the 'InitialContextFactory' implementation class to use.</td>
</tr>
<tr>
<td>jndiURL</td>
<td></td>
<td>Specifies the JNDI provider URL</td>
</tr>
<tr>
<td>jndi-*</td>
<td></td>
<td>Additional parameters for a JNDI provider</td>
</tr>
<tr>
<td>messageType</td>
<td>byte</td>
<td>JMS message type used by CXF (byte, text or binary)</td>
</tr>
<tr>
<td>password</td>
<td></td>
<td>Password for creating the connection. Using this in the URI is discouraged</td>
</tr>
<tr>
<td>priority</td>
<td>4</td>
<td>Priority for the messages. See your JMS provider documentation for details. Values range from 0 to 9 where 0 is lowest priority</td>
</tr>
<tr>
<td>replyToName</td>
<td></td>
<td>Specifies the JNDI name bound to the JMS destinations where replies are sent</td>
</tr>
<tr>
<td>receiveTimeout</td>
<td>60000</td>
<td>Timeout in milliseconds the client waits for a reply in case of request / reply exchanges</td>
</tr>
<tr>
<td>reconnectOnException</td>
<td>true</td>
<td>Should the transport reconnect in case of exceptions. From version 3.0.0 on the transport will always reconnect in case of exceptions</td>
</tr>
<tr>
<td>targetService</td>
<td></td>
<td>Used by the service implementation to dispatch the service request.</td>
</tr>
<tr>
<td>timeToLive</td>
<td>0</td>
<td>Time (in ms) after which the message will be discarded by the jms provider</td>
</tr>
</tbody>
</table>
### Configuring SOAP over JMS

<table>
<thead>
<tr>
<th>Query Parameter</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>topicReplyToName</td>
<td></td>
<td>Reply to messages on a topic with this name. Depending on the variant this is either a jndi or jms name.</td>
</tr>
<tr>
<td>useConduitIdSelector</td>
<td>true</td>
<td>Each conduit is assigned with a UUID. If set to true this conduit id will be the prefix for all correlation ids. This allows several endpoints to share a JMS queue or topic</td>
</tr>
<tr>
<td>username</td>
<td></td>
<td>Username for creating the connection</td>
</tr>
</tbody>
</table>

Some of these attributes are specified in the JMS URI specification.

Further parameters are supported by the underlying CXF 3.x, namely jndiTransactionManager, which allows the configuration of JTA transactions around JMS message processing. However, this is an advanced feature for which it is recommended to read the CXF documentation and the documentation of the MOM in use.

Depending of the MOM used, the connection URI can look differently. For more information on how the address URI for connection to ActiveMQ looks like, see `Connecting to ActiveMQ`, and for more information on how the address URI for connection to Websphere MQ looks like, see `Connecting to Websphere MQ`.

### 10.2.1. Connecting to ActiveMQ

For connection to ActiveMQ:

- **JMS_broker_URL** for ActiveMQ has the following structure:

  tcp://<host>:<port>

- **connection_factory_class_name** should be `org.apache.activemq.jndi.ActiveMQInitialContextFactory`.

- **connection_factory_name** is usually `ConnectionFactory`.

- **variant** should take the `jndi` or `jndi-topic` value to connect to a queue or a topic respectively. However, `queue` or `topic` work also for ActiveMQ.

In case of connection to a dynamic queue/topic, the destination name needs to be prefixed with `dynamicQueues/` or `dynamicTopics/` respectively.

Below is an example of connection to a ActiveMQ dynamic queue called “test.queue” with a broker running on the localhost port 61616:

**ActiveMQ connection to queue URI**

```xml
jms:jndi:dynamicQueues/test.queue?
```

Below is an example of connection to the dynamic topic “test.topic” with the broker running on localhost port 61616:

**ActiveMQ connection to a topic URI**

```xml
jms:jndi-topic:dynamicTopics/test.topic?
```
10.2.2. Connecting to Websphere MQ

For connection to Websphere MQ:

- **JMS_broker_URL** is either not set at all, or needs to have the same value as the `clientConnection` parameter:

  `<hostname>:<port>`

- **context_factory_class_name** should be `org.talend.esb.jms.wmq.Nojndi`.

  This is a wrapper around the pseudo InitialContextFactory `Nojndi` from IBM which is included in the Websphere MQ JMS support libraries. The Talend ESB `Nojndi` wrapper is included in the Talend ESB Runtime Enterprise Edition in the file `tesb-jms-transport-enterprise.jar`. It adds topic destination support to the wrapped IBM `Nojndi` and a workaround which avoids some spurious error messages the IBM `Nojndi` tends to write to `stderr`.

- **connection_factory_name** is a Websphere MQ-specific connection parameter string which is equal to the Websphere MQ connection access strings used by non-JMS clients.

  The **Websphere MQ connection parameter string** looks like the following:

  ```
  connectQueueManager(<queue_manager>)binding(client)clientChannel(<channel_name>)clientConnection(<mq_host_name>:<mq_port>)
  ```

  Where:

  - For `connectQueueManager`, `<queue_manager>` is the name of the Websphere MQ queue manager which manages the requested destination, for example: `QMGR`, `QMO1` or something similar.

  - For `binding`, `client` should be set to the literal value `client` for JMS.

  - For `clientChannel`, `<channel_name>` is the name or the Websphere MQ channel through which the requested destination is to be accessed, for example: `EXAMPLE.CHANNEL.SVRCONN`.

  - For `clientConnection`, `<mq_host_name>:<mq_port>` corresponds to the network address `<mq_host_name>` with port `<mq_port>` of the Websphere MQ server to connect to, for example: `examplehost:1414` or `10.1.2.3:1414`.

  - **variant** should take the `queue` or `topic` value to connect to a queue or a topic respectively.

  - **jndiURL** needs to be set to a non-empty value. The recommendation is `wmq://queue` for queue connections and `wmq://topic` for topic connections.

Below is an example of connection to a Webpshere MQ queue called `test.queue` with broker running on localhost port `1414`. The channel `EXAMPLE.CHANNEL.SVRCONN` and the queue manager `QMGR` will be used to connect to the queue.

**Websphere MQ connection to queue URI**

```
jms:queue:test.queue?
jndiInitialContextFactory=org.talend.esb.jms.wmq.Nojndi&jndiConnectionFactoryName=connectQueueManager(QMGR)binding(client)clientChannel(EXAMPE.CHANNEL.SVRCONN)clientConnection(localhost:1414)&jndiURL=wmq://queue
```
When connecting to a topic, an additional JMS URI parameter is required: 
\texttt{jndi-destination-type=topic}. Starting with the version 6.1.1 of Talend ESB, this parameter is optional if \texttt{jndiURL=wmq://topic}.

Below is an example showing connection to the topic \texttt{test.topic} to the same broker using the same channel and queue manager QMGR:

\textbf{Websphere MQ topic connection URI}

\begin{verbatim}
jms:topic:test.topic?
  jndiInitialContextFactory=org.talend.esb.jms.wmq.Nojndi
  &jndiConnectionFactoryName=connectQueueManager(QMGR)
  binding(client)
  clientChannel(EXAMPE.CHANNEL.SVRCONN)
  clientConnection(localhost:1414)
  &jndiURL=wmq://topic
  &jndi-destination-type=topic
\end{verbatim}

\section*{10.2.3. Wrapping IBM MQ client library JARs into an OSGi bundle}

This section describes how to wrap IBM WMQ client library jars into an OSGi bundle that can be used to create client connections to WMQ in an OSGi environment.

\textbf{Prerequisites:}

The following WMQ JARs (version 7.5) should be installed into the local maven repository:

- CL3Export.jar
- CL3Nonexport.jar
- com.ibm.mq.commonservices.jar
- com.ibm.mq.headers.jar
- com.ibm.mq.jmqi.jar
- com.ibm.mq.jms.Nojndi.jar
- com.ibm.mq.pcf.jar
- com.ibm.mq.jms.jar
- dhbcore.jar
- rmm.jar

To install JAR files into local repository, run the following commands from the directory that contains the JARS:

\begin{verbatim}
mvn install:install-file -Dfile=dhbcore.jar -DgroupId=com.ibm -DartifactId=com.ibm.disthub2.dhbcore -Dversion=7.5 -Dpackaging=jar


mvn install:install-file -Dfile=com.ibm.mq.jms.jmqi.jar -DgroupId=com.ibm -DartifactId=com.ibm.mq.jms.jmqi -Dversion=7.5 -Dpackaging=jar

mvn install:install-file -Dfile=com.ibm.mq.jms.jar -DgroupId=com.ibm -DartifactId=com.ibm.mq.jms -Dversion=7.5 -Dpackaging=jar
\end{verbatim}
1. Add the file `pom.xml` containing the following content into an empty directory:

```xml
<project xmlns="http://maven.apache.org/POM/4.0.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
    http://maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <groupId>osgi.com.ibm</groupId>
  <artifactId>wsmq</artifactId>
  <version>7.5</version>
  <packaging>bundle</packaging>
  <name>Websphere MQ client libraries OSGi Bundle</name>
  <description>This OSGi bundle simply wraps several WMQ artifacts into one.</description>
  <properties>
    <wmq.version>${project.version}</wmq.version>
  </properties>
  <dependencies>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>com.ibm.mq.jms.Nojndi</artifactId>
      <version>${wmq.version}</version>
    </dependency>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>com.ibm.mq.jmqi</artifactId>
      <version>${wmq.version}</version>
    </dependency>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>com.ibm.mqjms</artifactId>
      <version>${wmq.version}</version>
    </dependency>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>com.ibm.disthub2.dhbcore</artifactId>
      <version>${wmq.version}</version>
    </dependency>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>com.ibm.mq.headers</artifactId>
      <version>${wmq.version}</version>
    </dependency>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>com.ibm.mq.commonservices</artifactId>
      <version>${wmq.version}</version>
    </dependency>
    <dependency>
      <groupId>com.ibm</groupId>
      <artifactId>rmm</artifactId>
      <version>${wmq.version}</version>
    </dependency>
  </dependencies>
</project>
```
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```xml
<version>2.1.0</version>
<extensions>true</extensions>
<configuration>
  <instructions>
    <Bundle-SymbolicName>wmq-osgi-bundle</Bundle-SymbolicName>
    <Export-Package>*</Export-Package>
    <Import-Package>
      com.ibm.disthub2.impl.multi.*;resolution:=optional,
      com.ibm.disthub2.impl.multicast.server;resolution:=optional,
      com.ibm.disthub2.impl.server;resolution:=optional,
      com.ibm.disthub2.impl.server.*;resolution:=optional,
      com.ibm.disthub2.impl.util.*;resolution:=optional,
      com.ibm.ejs.*;resolution:=optional,
      com.ibm.rmm.ptl.tchan.*;resolution:=optional,
      com.ibm.disthub2.broker.reference.security;resolution:=optional,
      com.ibm.misc;resolution:=optional, com.ibm.mq.internal;resolution:=optional,
      com.ibm.crypto.pkcs11impl.provider;resolution:=optional,
      com.ibm.crypto.provider;resolution:=optional,
      com.ibm.security.*;resolution:=optional,
      sun.net.www;resolution:=optional, sun.security.*;resolution:=optional, *
    </Import-Package>
    <_versionpolicy>
      <Import-Package>
        <![CDATA[($({version};==;${@})),${version}+(${@})]]></Import-Package>
      </_versionpolicy>
      <_removeheaders>Ignore-Package,Include-Resource,Private-Package,Embed-Dependency</_removeheaders>
    </instructions>
  </configuration>
</plugins>
</build>
</project>
```

2. Go to the directory that contains the pom.xml and create a subdirectory src/main/resources/META-INF.

3. Place the file compinfo.properties containing the following content to the directory src/main/resources/META-INF:

```properties
CompList: comp1,comp2,comp3,comp4
comp1_CompClass: com.ibm.msg.client.wmq.factories.WMQComponent
comp3_CompClass: com.ibm.msg.client.jms.internal.JMSComponent
comp4_CompClass: com.ibm.mq.jms.MQJMSComponent
```

4. Go to the directory that contains the pom.xml file and use the following command:

```
mvn clean install
```

During Maven build on Linux, a RuntimeException may occur with the message: "data starting at XX is in unknown format". This Exception is harmless and does not affect the build result.

5. The bundle file wsmq-7.5.jar will appear in the subdirectory target/. This bundle can be used for deployment into OSGi.

6. To deploy the bundle, copy the wsmq-7.5.jar file to the directory <TESB-HOME>/container/deploy.
10.3. SAML audience workaround for SOAP

A new security feature named audience restriction check has been introduced in CXF 3. However, this feature is supported only in CXF versions 3.2.0 and above. Using it in earlier CXF versions causes security failures when using SAML with JMS.

As the support for audience restriction check with JMS is available only with CXF 3.2.0, a workaround that allows running SAML with JMS is needed. Setting the JAX-WS property `security.sts.applies-to` to the value of the QName on the consumer side, is the workaround that applies to this scenario.

For example, in case of Spring configuration, the property can be configured in the JAX-WS properties section of the consumer configuration like this:

```<entry key="security.sts.applies-to" value="{http://services.talend.org/demos/Library/1.0}LibraryProvider"/></entry>```

The full example can be found in Library Service example: `<TESB-HOME>/examples/tesb/library-service`

10.4. Durable subscription

The JMS specification defines the **durable subscription**. Basically, it is used when a subscriber needs to receive all the messages published to a topic, even those which are sent while the subscriber is off-line. Here is a quote from JMS 2.0 specification:

"A durable subscription is used by an application that needs to receive all the messages published on a topic, including the ones published when there is no consumer associated with it. The JMS provider retains a record of this durable subscription and ensures that all messages from the topic’s publishers are retained until they are delivered to, and acknowledged by, a consumer on the durable subscription or until they have expired."

Durable subscription is often used for the Notification message exchange pattern. For more information about the Notification message exchange pattern, see [Notification](#).

For more information on how to connect to the topic in a durable way using ActiveMQ, see [ActiveMQ durable subscription](#) and using Websphere MQ, see [Websphere MQ durable subscription](#).

10.4.1. ActiveMQ durable subscription

To connect to an ActiveMQ topic in a durable way, an additional parameter called `durableSubscriptionName` has to be specified in the connection URI. However, there is a limitation that from the side of one client, only one subscriber can be connected simultaneously to a given topic using a given durable subscription name. For example:

```jms:jndi-topic:dynamicTopics/newBooksTopic.topic?
jndiInitialContextFactory=org.apache.activemq.jndi.Active```
MQInitialContextFactory&jndiConnectionFactoryName=ConnectionFactory&jndiURL=tcp://localhost:61616&durableSubscriptionName=mySubscription

The JMS specification prohibits two or more subscribers using the same `durableSubscriptionName` and `durableSubscriptionClientId` to be connected to the same topic simultaneously. When using one WSDL for creation, for example provider and consumer (or multiple consumers), which is a usual situation, this becomes a problem, because the same JMS connection URI is shared among multiple participants. This means that if `durableSubscriptionName` or `durableSubscriptionClientId` is specified in the URI in the WSDL, all the participants will use the same parameters and only one of the participants will be allowed to connect to the topic by a message broker.

To manage this situation, a special Talend ESB feature called `DurableSubscriptionFeature` has been created. The feature is part of the `transport-jms` library, so no other dependencies are needed. The feature allows to specify `durableSubscriptionName` and `durableSubscriptionClientId` parameters individually for a participant. Here is an example of how to configure it in Spring configuration:

```xml
<bean id="subscriberDurableSubscriptionFeature" class="org.talend.esb.transport.jms.DurableSubscriptionFeature">
    <property name="durableSubscriptionClientId" value="someClientId"/>
    <property name="durableSubscriptionName" value="someSubscriptionName"/>
</bean>

<jaxws:endpoint xmlns:library="http://services.talend.org/demos/Library/1.0" id="LibraryNotificationReceiver"
    serviceName="library:LibraryProvider" endpointName="library:LibraryTopicPort"
    implementor="org.talend.services.demos.client.LibraryNotificationReceiverImpl">
    <jaxws:features>
        <ref bean="subscriberDurableSubscriptionFeature"/>
    </jaxws:features>
</jaxws:endpoint>
```

Note that to make `DurableSubscriptionFeature` work, the `durableSubscriptionName` parameter should be specified in the URI. The value of the parameter will be replaced with the one provided by the feature.

### 10.4.2. Websphere MQ durable subscription

With the Talend ESB `Nojndi` wrapper as `InitialContextFactory`, durable subscription in Websphere MQ is configured in the same way as described for ActiveMQ in the previous section. See below a sample JMS URI for Websphere MQ topic access with durable subscription:

```xml
jms:topic:test.durable.topic?
jndiInitialContextFactory=org.talend.esb.jms.wmq.Nojndi&jndiConnectionFactoryName=connectQueueManager(QMGR)binding(client)clientChannel(EXAMPE.CHANNEL.SVRCONN)clientConnection(localhost:1414)&jndiURL=wmq://topic&jndi-destination-type=topic&durableSubscriptionName=myDurableSubscription
```
10.5. Cipher Suite for Websphere MQ

When a Websphere MQ client wants to connect through an SSL-secured channel, it needs to set up its JSSE security (keystore and truststore parameters), and it needs to define a cipher suite for the connection which matches the Websphere MQ server-side cipher spec.

The easiest way of setting up the ciphersuite is by enhancing the value of jndiConnectionFactoryName in the SOAPJMS URI. For an SSL-secured channel, it becomes:

**Websphere MQ secured connection parameters**

```
connectQueueManager(<queue_manager>)binding(client)clientChannel(<channel_name>)clientConnection(<mq_host_name>:<mq_port>)sslCipherSuite(<cipher_suite>)
```

Where:

- For `sslCipherSuite`, `<cipher_suite>` is the cipher suite value, for example: `SSL_RSA_WITH_DES_CBC_SHA`.

See below further SSL settings which can be added as connection parameters:

- For `sslPeerName`, `<peer_name>` is the expected distinguished name of the subject in the certificate presented by the MQ server. If this parameter is set, a secured connection will only be opened if the subject value in the SSL certificate presented by the Websphere MQ server equals the value of `peer_name`.

- For `sslKeyStore`, `<local_key_store_path>` is the file path to the Java key store for client-side SSL keys. This value is usually not set in the connection parameters, but in System property `javax.net.ssl.keyStore`.

- For `sslKeyStorePassword`, `<password>` is the acces password for the SSL key store. This value is usually not set in the connection parameters, but in System property `javax.net.ssl.keyStorePassword`.

- For `sslTrustStore`, `<local_key_store_path>` is the file path to the Java key store for server certificates. This value is usually not set in the connection parameters, but in System property `javax.net.ssl.trustStore`.

- For `sslTrustStorePassword`, `<password>` is the access password to the SSL trust store. This value is usually not set in the connection parameters, but in System property `javax.net.ssl.trustStorePassword`.

- For `sslKeyResetCount`, `<byte_count>` is the number of bytes which can be sent until an SSL key re-negotiation must occur. The default value is 0, it means "unlimited".

- For `sslFipsRequired`, (yes) or (no) restricts the use of CipherSuite. When set to no, the default, any CipherSuite that is not supported by FIPS can be used. When set to yes, only a CipherSuite supported by FIPS can be used.

- For `sslLDAPCRLServers`, `<server_list>` is a list of LDAP servers to be checked when searching for certificate revocation lists. If not set, there is no certificate checking for revocation.

Below is an example of an SSL-secured connection to a Webpsphere MQ queue called "test.queue" with broker running on examplehost port 1414. The channel EXAMPLE.SECURED.SVRCONN,
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queue manager QMGR, and cipher suite SSL_RSA_WITH_DES_CBC_SHA are used to connect to the queue.

**Websphere MQ secured connection URI**

```
jms:queue:test.queue?
jndiInitialContextFactory=org.talend.esb.jms.wmq.Nojndi&jndiConnectionFactoryName=
connectQueueManager(QMGR)binding(client)clientChannel(EXAMPE.SECURED.SVRCONN)clientC
onnexion(examplehost:1414)sslCipherSuite(SSL_RSA_WITH_DES_CBC_SHA)&jndiURL=wmq://
queue
```

When setting the cipher suite in the SOAPJMS URI is not possible or desired, it can also be setup locally. The local setup of the `cipherSuite` connection parameter for Websphere MQ is a responsibility of a custom code of a client or service. To specify a cipher suite for connection, the CipherSuite name should be set in the custom code `sslCipherSuite` field in the `MQEnvironment` class. This should be done before setting up the connection to the message broker. For example, to use the SSL_RSA_WITH_DES_CBC_SHA cipher suite, the following Java code should be executed before connecting to the message broker:

```java
MQEnvironment.sslCipherSuite = "SSL_RSA_WITH_DES_CBC_SHA";
```

When using CXF with Spring configuration, this could be done, for example, in the `afterPropertiesSet()` method of the implementor class.

For example, if you use a class named `LibraryServerImpl`, which implements the functionality of a some service. In the Spring configuration file, this may look like:

**Setting CipherSuite for WS MQ Spring configuration**

```xml
<bean id="libraryServerImpl"
class="org.talend.services.demos.server.LibraryServerImpl"/>
<jaxws:endpoint xmlns:library="http://services.talend.org/demos/Library/1.0"
  id="LibraryProviderJMS"
  address="jms:queue:testQueue?
jndiInitialContextFactory=com.ibm.mq.jms.context.WMQInitialContextFactory&jndiCo
nnectionFactoryName=QCF1&jndiURL=example.com:1414/
VERYSECURE.CHANNEL.SVRCONN"
  serviceName="library:LibraryProvider"
  endpointName="library:LibraryJmsPort"
  implementor="#libraryServerImpl">
</jaxws:endpoint>
```

And the `LibraryServerImpl` class looks like the following:

**Set cipher suite in afterPropertiesSet() method of the implementing class**

```java
public class LibraryServerImpl implements Library, InitializingBean {
    ...
    Service implementing code here
    ...

    @Override
    public void afterPropertiesSet() throws Exception {
        // Set up ciphersuite for connection
        MQEnvironment.sslCipherSuite = "SSL_RSA_WITH_DES_CBC_SHA";
    }
}
```
But of course, setting up cipher suite could be done in other ways, but it should be done before setting up connection to the Websphere MQ broker.

10.6. Robust communication

10.6.1. Reconnect

If the connection with a JMS broker is interrupted, the client and the server have to restore the connection.

This functionality is provided by CXF, which is included in Talend ESB, in the MessageContainerListener. The listener checks the connection, reports warning if the connection is broken and restores the connection if possible.

When using Connection Pooling, broken connections are not automatically removed from the pool. The solution is to set short expire timeout for connections in pool:

```java
import org.apache.activemq.ActiveMQConnectionFactory;
import org.apache.activemq.pool.PooledConnectionFactory;

ConnectionFactory cf = new ActiveMQConnectionFactory("tcp://localhost:61616");
PooledConnectionFactory pcf = new PooledConnectionFactory();
pcf.setExpiryTimeout(5000); // Make sure to set expiry timeout as the default of 0 prevents reconnect on failures
pcf.setConnectionFactory(cf);

JMSConfiguration jmsConfig = new JMSConfiguration();
jmsConfig.setConnectionFactory(pcf);
```