Spring Web Services Reference Documentation

2.2.3.RELEASE

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Preface

In the current age of Service Oriented Architectures, more and more people are using Web Services to connect previously unconnected systems. Initially, Web services were considered to be just another way to do a Remote Procedure Call (RPC). Over time however, people found out that there is a big difference between RPCs and Web services. Especially when interoperability with other platforms is important, it is often better to send encapsulated XML documents, containing all the data necessary to process the request. Conceptually, XML-based Web services are better off being compared to message queues rather than remoting solutions. Overall, XML should be considered the platform-neutral representation of data, the *interlingua* of SOA. When developing or using Web services, the focus should be on this XML, and not on Java.

Spring Web Services focuses on creating these document-driven Web services. Spring Web Services facilitates contract-first SOAP service development, allowing for the creation of flexible web services using one of the many ways to manipulate XML payloads. Spring-WS provides a powerful message dispatching framework, a WS-Security solution that integrates with your existing application security solution, and a Client-side API that follows the familiar Spring template pattern.

Part I. Introduction

This first part of the reference documentation is an overview of Spring Web Services and the underlying concepts. Spring-WS is then introduced, and the concepts behind contract-first Web service development are explained.

1. What is Spring Web Services?

1.1 Introduction

Spring Web Services (Spring-WS) is a product of the Spring community focused on creating document-driven Web services. Spring Web Services aims to facilitate contract-first SOAP service development, allowing for the creation of flexible web services using one of the many ways to manipulate XML payloads. The product is based on Spring itself, which means you can use the Spring concepts such as dependency injection as an integral part of your Web service.

People use Spring-WS for many reasons, but most are drawn to it after finding alternative SOAP stacks lacking when it comes to following Web service best practices. Spring-WS makes the best practice an easy practice. This includes practices such as the WS-I basic profile, Contract-First development, and having a loose coupling between contract and implementation. The other key features of Spring Web services are:

Powerful mappings. You can distribute incoming XML requests to any object, depending on message payload, SOAP Action header, or an XPath expression.

XML API support. Incoming XML messages can be handled not only with standard JAXP APIs such as DOM, SAX, and StAX, but also JDOM, dom4j, XOM, or even marshalling technologies.

Flexible XML Marshalling. Spring Web Services builds on the Object/XML Mapping module in the Spring Framework, which supports JAXB 1 and 2, Castor, XMLBeans, JiBX, and XStream.

Reuses your Spring expertise. Spring-WS uses Spring application contexts for all configuration, which should help Spring developers get up-to-speed nice and quickly. Also, the architecture of Spring-WS resembles that of Spring-MVC.

Supports WS-Security. WS-Security allows you to sign SOAP messages, encrypt and decrypt them, or authenticate against them.

Integrates with Spring Security. The WS-Security implementation of Spring Web Services provides integration with Spring Security. This means you can use your existing Spring Security configuration for your SOAP service as well.

Apache license. You can confidently use Spring-WS in your project.

1.2 Runtime environment

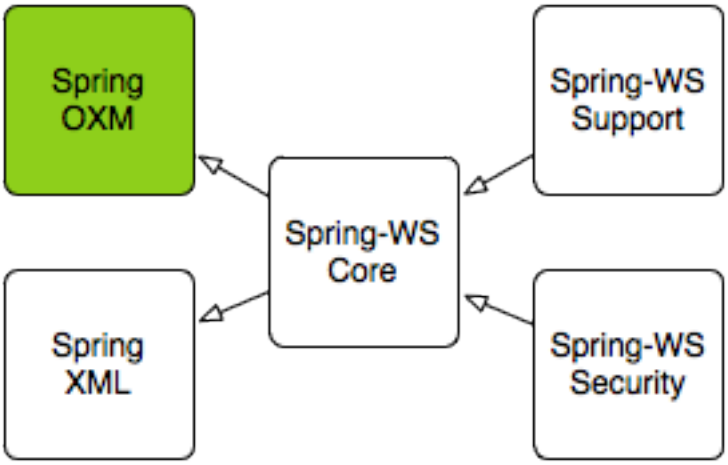
Spring Web Services requires a standard Java 1.6 Runtime Environment. Java 1.7 and 1.8 are also supported. Spring-WS also requires Spring 3.2 or higher.

Spring-WS consists of a number of modules, which are described in the remainder of this section.

- The XML module (`spring-xml.jar`) contains various XML support classes for Spring Web Services. This module is mainly intended for the Spring-WS framework itself, and not a Web service developers.
- The Core module (`spring-ws-core.jar`) is the central part of the Spring's Web services functionality. It provides the central `WebServiceMessage` and `SoapMessage` interfaces, the server-side framework, with powerful message dispatching, and the various support classes for implementing Web service endpoints; and the client-side `WebServiceTemplate`.

- The Support module (`spring-ws-support.jar`) contains additional transports (JMS, Email, and others).
- The Security package (`spring-ws-security.jar`) provides a WS-Security implementation that integrates with the core Web service package. It allows you to add principal tokens, sign, and decrypt and encrypt SOAP messages. Additionally, it allows you to leverage your existing Spring Security security implementation for authentication and authorization.

The following figure illustrates the Spring-WS modules and the dependencies between them. Arrows indicate dependencies, i.e. Spring-WS Core depends on Spring-XML and the OXM module found in Spring 3 and higher.



Dependencies between Spring-WS modules

1.3 Supported standards

Spring Web Services supports the following standards:

- SOAP 1.1 and 1.2
- WSDL 1.1 and 2.0 (XSD-based generation only supported for WSDL 1.1)
- WS-I Basic Profile 1.0, 1.1, 1.2 and 2.0
- WS-Addressing 1.0 and the August 2004 draft
- SOAP Message Security 1.1, Username Token Profile 1.1, X.509 Certificate Token Profile 1.1, SAML Token Profile 1.1, Kerberos Token Profile 1.1, Basic Security Profile 1.1

2. Why Contract First?

2.1 Introduction

When creating Web services, there are two development styles: *Contract Last* and *Contract First*. When using a contract-last approach, you start with the Java code, and let the Web service contract (WSDL, see sidebar) be generated from that. When using contract-first, you start with the WSDL contract, and use Java to implement said contract.

> **What is WSDL?**
>
> WSDL stands for Web Services Description Language. A WSDL file is an XML document that describes a Web service. It specifies the location of the service and the operations (or methods) the service exposes. For more information about WSDL, refer to the WSDL specification, or read the WSDL tutorial

Spring-WS only supports the contract-first development style, and this section explains why.

2.2 Object/XML Impedance Mismatch

Similar to the field of ORM, where we have an Object/Relational impedance mismatch, there is a similar problem when converting Java objects to XML. At first glance, the O/X mapping problem appears simple: create an XML element for each Java object, converting all Java properties and fields to sub-elements or attributes. However, things are not as simple as they appear: there is a fundamental difference between hierarchical languages such as XML (and especially XSD) and the graph model of Java[4].

XSD extensions

In Java, the only way to change the behavior of a class is to subclass it, adding the new behavior to that subclass. In XSD, you can extend a data type by restricting it: that is, constraining the valid values for the elements and attributes. For instance, consider the following example:

```
<simpleType name="AirportCode">
  <restriction base="string">
      <pattern value="[A-Z][A-Z][A-Z]"/>
  </restriction>
</simpleType>
```

This type restricts a XSD string by ways of a regular expression, allowing only three upper case letters. If this type is converted to Java, we will end up with an ordinary `java.lang.String`; the regular expression is lost in the conversion process, because Java does not allow for these sorts of extensions.

Unportable types

One of the most important goals of a Web service is to be interoperable: to support multiple platforms such as Java, .NET, Python, etc. Because all of these languages have different class libraries, you must use some common, interlingual format to communicate between them. That format is XML, which is supported by all of these languages.

[4] Most of the contents in this section was inspired by [alpine] and [effective-enterprise-java].

Because of this conversion, you must make sure that you use portable types in your service implementation. Consider, for example, a service that returns a `java.util.TreeMap`, like so:

```
public Map getFlights() {
  // use a tree map, to make sure it's sorted
  TreeMap map = new TreeMap();
  map.put("KL1117", "Stockholm");
  ...
  return map;
}
```

Undoubtedly, the contents of this map can be converted into some sort of XML, but since there is no *standard* way to describe a map in XML, it will be proprietary. Also, even if it can be converted to XML, many platforms do not have a data structure similar to the `TreeMap`. So when a .NET client accesses your Web service, it will probably end up with a `System.Collections.Hashtable`, which has different semantics.

This problem is also present when working on the client side. Consider the following XSD snippet, which describes a service contract:

```
<element name="GetFlightsRequest">
  <complexType>
    <all>
      <element name="departureDate" type="date"/>
      <element name="from" type="string"/>
      <element name="to" type="string"/>
    </all>
  </complexType>
</element>
```

This contract defines a request that takes an date, which is a XSD datatype representing a year, month, and day. If we call this service from Java, we will probably use either a `java.util.Date` or `java.util.Calendar`. However, both of these classes actually describe times, rather than dates. So, we will actually end up sending data that represents the fourth of April 2007 at midnight (`2007-04-04T00:00:00`), which is not the same as `2007-04-04`.

Cyclic graphs

Imagine we have the following simple class structure:

```
public class Flight {
  private String number;
  private List<Passenger> passengers;

  // getters and setters omitted
}

public class Passenger {
  private String name;
  private Flight flight;

  // getters and setters omitted
}
```

This is a cyclic graph: the `Flight` refers to the `Passenger`, which refers to the `Flight` again. Cyclic graphs like these are quite common in Java. If we took a naive approach to converting this to XML, we will end up with something like:

```
<flight number="KL1117">
  <passengers>
    <passenger>
      <name>Arjen Poutsma</name>
      <flight number="KL1117">
        <passengers>
          <passenger>
            <name>Arjen Poutsma</name>
            <flight number="KL1117">
              <passengers>
                <passenger>
                   <name>Arjen Poutsma</name>
                   ...
```

which will take a pretty long time to finish, because there is no stop condition for this loop.

One way to solve this problem is to use references to objects that were already marshalled, like so:

```
<flight number="KL1117">
  <passengers>
    <passenger>
      <name>Arjen Poutsma</name>
      <flight href="KL1117" />
    </passenger>
    ...
  </passengers>
</flight>
```

This solves the recursiveness problem, but introduces new ones. For one, you cannot use an XML validator to validate this structure. Another issue is that the standard way to use these references in SOAP (RPC/encoded) has been deprecated in favor of document/literal (see WS-I Basic Profile).

These are just a few of the problems when dealing with O/X mapping. It is important to respect these issues when writing Web services. The best way to respect them is to focus on the XML completely, while using Java as an implementation language. This is what contract-first is all about.

2.3 Contract-first versus Contract-last

Besides the Object/XML Mapping issues mentioned in the previous section, there are other reasons for preferring a contract-first development style.

Fragility

As mentioned earlier, the contract-last development style results in your web service contract (WSDL and your XSD) being generated from your Java contract (usually an interface). If you are using this approach, you will have no guarantee that the contract stays constant over time. Each time you change your Java contract and redeploy it, there might be subsequent changes to the web service contract.

Aditionally, not all SOAP stacks generate the same web service contract from a Java contract. This means changing your current SOAP stack for a different one (for whatever reason), might also change your web service contract.

When a web service contract changes, users of the contract will have to be instructed to obtain the new contract and potentially change their code to accommodate for any changes in the contract.

In order for a contract to be useful, it must remain constant for as long as possible. If a contract changes, you will have to contact all of the users of your service, and instruct them to get the new version of the contract.

Performance

When Java is automatically transformed into XML, there is no way to be sure as to what is sent across the wire. An object might reference another object, which refers to another, etc. In the end, half of the objects on the heap in your virtual machine might be converted into XML, which will result in slow response times.

When using contract-first, you explicitly describe what XML is sent where, thus making sure that it is exactly what you want.

Reusability

Defining your schema in a separate file allows you to reuse that file in different scenarios. If you define an AirportCode in a file called `airline.xsd`, like so:

```
<simpleType name="AirportCode">
    <restriction base="string">
        <pattern value="[A-Z][A-Z][A-Z]"/>
    </restriction>
</simpleType>
```

You can reuse this definition in other schemas, or even WSDL files, using an `import` statement.

Versioning

Even though a contract must remain constant for as long as possible, they *do* need to be changed sometimes. In Java, this typically results in a new Java interface, such as `AirlineService2`, and a (new) implementation of that interface. Of course, the old service must be kept around, because there might be clients who have not migrated yet.

If using contract-first, we can have a looser coupling between contract and implementation. Such a looser coupling allows us to implement both versions of the contract in one class. We could, for instance, use an XSLT stylesheet to convert any "old-style" messages to the "new-style" messages.

3. Writing Contract-First Web Services

3.1 Introduction

This tutorial shows you how to write contract-first Web services, that is, developing web services that start with the XML Schema/WSDL contract first followed by the Java code second. Spring-WS focuses on this development style, and this tutorial will help you get started. Note that the first part of this tutorial contains almost no Spring-WS specific information: it is mostly about XML, XSD, and WSDL. The second part focuses on implementing this contract using Spring-WS .

The most important thing when doing contract-first Web service development is to try and think in terms of XML. This means that Java-language concepts are of lesser importance. It is the XML that is sent across the wire, and you should focus on that. The fact that Java is used to implement the Web service is an implementation detail. An important detail, but a detail nonetheless.

In this tutorial, we will define a Web service that is created by a Human Resources department. Clients can send holiday request forms to this service to book a holiday.

3.2 Messages

In this section, we will focus on the actual XML messages that are sent to and from the Web service. We will start out by determining what these messages look like.

Holiday

In the scenario, we have to deal with holiday requests, so it makes sense to determine what a holiday looks like in XML:

```
<Holiday xmlns="http://mycompany.com/hr/schemas">
    <StartDate>2006-07-03</StartDate>
    <EndDate>2006-07-07</EndDate>
</Holiday>
```

A holiday consists of a start date and an end date. We have also decided to use the standard ISO 8601 date format for the dates, because that will save a lot of parsing hassle. We have also added a namespace to the element, to make sure our elements can used within other XML documents.

Employee

There is also the notion of an employee in the scenario. Here is what it looks like in XML:

```
<Employee xmlns="http://mycompany.com/hr/schemas">
    <Number>42</Number>
    <FirstName>Arjen</FirstName>
    <LastName>Poutsma</LastName>
</Employee>
```

We have used the same namespace as before. If this `<Employee/>` element could be used in other scenarios, it might make sense to use a different namespace, such as `http://mycompany.com/employees/schemas`.

HolidayRequest

Both the holiday and employee element can be put in a `<HolidayRequest/>`:

```
<HolidayRequest xmlns="http://mycompany.com/hr/schemas">
    <Holiday>
        <StartDate>2006-07-03</StartDate>
        <EndDate>2006-07-07</EndDate>
    </Holiday>
    <Employee>
        <Number>42</Number>
        <FirstName>Arjen</FirstName>
        <LastName>Poutsma</LastName>
    </Employee>
</HolidayRequest>
```

The order of the two elements does not matter: `<Employee/>` could have been the first element just as well. What is important is that all of the data is there. In fact, the data is the only thing that is important: we are taking a *data-driven* approach.

3.3 Data Contract

Now that we have seen some examples of the XML data that we will use, it makes sense to formalize this into a schema. This data contract defines the message format we accept. There are four different ways of defining such a contract for XML:

- DTDs
- XML Schema (XSD)
- RELAX NG
- Schematron

DTDs have limited namespace support, so they are not suitable for Web services. Relax NG and Schematron certainly are easier than XML Schema. Unfortunately, they are not so widely supported across platforms. We will use XML Schema.

By far the easiest way to create an XSD is to infer it from sample documents. Any good XML editor or Java IDE offers this functionality. Basically, these tools use some sample XML documents, and generate a schema from it that validates them all. The end result certainly needs to be polished up, but it's a great starting point.

Using the sample described above, we end up with the following generated schema:

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        elementFormDefault="qualified"
        targetNamespace="http://mycompany.com/hr/schemas"
        xmlns:hr="http://mycompany.com/hr/schemas">
    <xs:element name="HolidayRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="hr:Holiday"/>
                <xs:element ref="hr:Employee"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="Holiday">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="hr:StartDate"/>
                <xs:element ref="hr:EndDate"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="StartDate" type="xs:NMTOKEN"/>
    <xs:element name="EndDate" type="xs:NMTOKEN"/>
    <xs:element name="Employee">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="hr:Number"/>
                <xs:element ref="hr:FirstName"/>
                <xs:element ref="hr:LastName"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="Number" type="xs:integer"/>
    <xs:element name="FirstName" type="xs:NCName"/>
    <xs:element name="LastName" type="xs:NCName"/>
</xs:schema>
```

This generated schema obviously can be improved. The first thing to notice is that every type has a root-level element declaration. This means that the Web service should be able to accept all of these elements as data. This is not desirable: we only want to accept a `<HolidayRequest/>`. By removing the wrapping element tags (thus keeping the types), and inlining the results, we can accomplish this.

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:hr="http://mycompany.com/hr/schemas"
        elementFormDefault="qualified"
        targetNamespace="http://mycompany.com/hr/schemas">
    <xs:element name="HolidayRequest">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Holiday" type="hr:HolidayType"/>
                <xs:element name="Employee" type="hr:EmployeeType"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:complexType name="HolidayType">
        <xs:sequence>
            <xs:element name="StartDate" type="xs:NMTOKEN"/>
            <xs:element name="EndDate" type="xs:NMTOKEN"/>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="EmployeeType">
        <xs:sequence>
            <xs:element name="Number" type="xs:integer"/>
            <xs:element name="FirstName" type="xs:NCName"/>
            <xs:element name="LastName" type="xs:NCName"/>
        </xs:sequence>
    </xs:complexType>
</xs:schema>
```

The schema still has one problem: with a schema like this, you can expect the following messages to validate:

```

<HolidayRequest xmlns="http://mycompany.com/hr/schemas">
    <Holiday>
        <StartDate>this is not a date</StartDate>
        <EndDate>neither is this</EndDate>
    </Holiday>
    <!-- ... -->
</HolidayRequest>
```

Clearly, we must make sure that the start and end date are really dates. XML Schema has an excellent built-in `date` type which we can use. We also change the `NCNames` to `strings`. Finally, we change the `sequence` in `<HolidayRequest/>` to `all`. This tells the XML parser that the order of `<Holiday/>` and `<Employee/>` is not significant. Our final XSD now looks like this:

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:hr="http://mycompany.com/hr/schemas"
        elementFormDefault="qualified"
        targetNamespace="http://mycompany.com/hr/schemas">
    <xs:element name="HolidayRequest">
        <xs:complexType>
            <xs:all>
                <xs:element name="Holiday" type="hr:HolidayType"/>                  ❶
                <xs:element name="Employee" type="hr:EmployeeType"/>
            </xs:all>
        </xs:complexType>
    </xs:element>
    <xs:complexType name="HolidayType">
        <xs:sequence>
            <xs:element name="StartDate" type="xs:date"/>
            <xs:element name="EndDate" type="xs:date"/>                             ❷
        </xs:sequence>                                                              ❷
    </xs:complexType>
    <xs:complexType name="EmployeeType">
        <xs:sequence>
            <xs:element name="Number" type="xs:integer"/>
            <xs:element name="FirstName" type="xs:string"/>
            <xs:element name="LastName" type="xs:string"/>                          ❸
        </xs:sequence>                                                              ❸
    </xs:complexType>
</xs:schema>
```

❶ `all` tells the XML parser that the order of `<Holiday/>` and `<Employee/>` is not significant.

❷ We use the `xsd:date` data type, which consist of a year, month, and day, for `<StartDate/>` and `<EndDate/>`.

❸ `xsd:string` is used for the first and last name.

We store this file as `hr.xsd`.

3.4 Service contract

A service contract is generally expressed as a WSDL file. Note that in Spring-WS, *writing the WSDL by hand is not required*. Based on the XSD and some conventions, Spring-WS can create the WSDL for you, as explained in the section entitled Section 3.6, “Implementing the Endpoint”. You can skip to the next section if you want to; the remainder of this section will show you how to write your own WSDL by hand.

We start our WSDL with the standard preamble, and by importing our existing XSD. To separate the schema from the definition, we will use a separate namespace for the WSDL definitions: `http://mycompany.com/hr/definitions`.

```
<wsdl:definitions xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
                  xmlns:schema="http://mycompany.com/hr/schemas"
                  xmlns:tns="http://mycompany.com/hr/definitions"
                  targetNamespace="http://mycompany.com/hr/definitions">
    <wsdl:types>
        <xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <xsd:import namespace="http://mycompany.com/hr/schemas"
 schemaLocation="hr.xsd"/>
        </xsd:schema>
    </wsdl:types>
```

Next, we add our messages based on the written schema types. We only have one message: one with the `<HolidayRequest/>` we put in the schema:

```
<wsdl:message name="HolidayRequest">
    <wsdl:part element="schema:HolidayRequest" name="HolidayRequest"/>
</wsdl:message>
```

We add the message to a port type as an operation:

```
<wsdl:portType name="HumanResource">
    <wsdl:operation name="Holiday">
        <wsdl:input message="tns:HolidayRequest" name="HolidayRequest"/>
    </wsdl:operation>
</wsdl:portType>
```

That finished the abstract part of the WSDL (the interface, as it were), and leaves the concrete part. The concrete part consists of a `binding`, which tells the client *how* to invoke the operations you've just defined; and a `service`, which tells it *where* to invoke it.

Adding a concrete part is pretty standard: just refer to the abstract part you defined previously, make sure you use *document/literal* for the `soap:binding` elements (`rpc/encoded` is deprecated), pick a `soapAction` for the operation (in this case `http://mycompany.com/RequestHoliday`, but any URI will do), and determine the `location` URL where you want request to come in (in this case `http://mycompany.com/humanresources`):

```
<wsdl:definitions xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
                  xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
                  xmlns:schema="http://mycompany.com/hr/schemas"
                  xmlns:tns="http://mycompany.com/hr/definitions"
                  targetNamespace="http://mycompany.com/hr/definitions">
    <wsdl:types>
        <xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
            <xsd:import namespace="http://mycompany.com/hr/schemas"                  ❶
                schemaLocation="hr.xsd"/>
        </xsd:schema>
    </wsdl:types>
    <wsdl:message name="HolidayRequest">                                             ❷
        <wsdl:part element="schema:HolidayRequest" name="HolidayRequest"/>           ❸
    </wsdl:message>
    <wsdl:portType name="HumanResource">                                             ❹
        <wsdl:operation name="Holiday">
            <wsdl:input message="tns:HolidayRequest" name="HolidayRequest"/>         ❷
        </wsdl:operation>
    </wsdl:portType>
    <wsdl:binding name="HumanResourceBinding" type="tns:HumanResource">
  ❹❺
        <soap:binding style="document"                                               ❻
            transport="http://schemas.xmlsoap.org/soap/http"/>                       ❼
        <wsdl:operation name="Holiday">
            <soap:operation soapAction="http://mycompany.com/RequestHoliday"/>       ❽
            <wsdl:input name="HolidayRequest">
                <soap:body use="literal"/>                                           ❻
            </wsdl:input>
        </wsdl:operation>
    </wsdl:binding>
    <wsdl:service name="HumanResourceService">
        <wsdl:port binding="tns:HumanResourceBinding" name="HumanResourcePort">      ❺
            <soap:address location="http://localhost:8080/holidayService/"/>         ❾
        </wsdl:port>
    </wsdl:service>
</wsdl:definitions>
```

❶ We import the schema defined in Section 3.3, “Data Contract”.

❷ We define the `HolidayRequest` message, which gets used in the `portType`.

❸ The `HolidayRequest` type is defined in the schema.

❹ We define the `HumanResource` port type, which gets used in the `binding`.

❺ We define the `HumanResourceBinding` binding, which gets used in the `port`.

❻ We use a document/literal style.

❼ The literal `http://schemas.xmlsoap.org/soap/http` signifies a HTTP transport.

❽ The `soapAction` attribute signifies the `SOAPAction` HTTP header that will be sent with every request.

❾ The `http://localhost:8080/holidayService/` address is the URL where the Web service can be invoked.

This is the final WSDL. We will describe how to implement the resulting schema and WSDL in the next section.

3.5 Creating the project

In this section, we will be using Maven3 to create the initial project structure for us. Doing so is not required, but greatly reduces the amount of code we have to write to setup our HolidayService.

The following command creates a Maven3 web application project for us, using the Spring-WS archetype (that is, project template)

```
mvn archetype:create -DarchetypeGroupId=org.springframework.ws \
  -DarchetypeArtifactId=spring-ws-archetype \
  -DarchetypeVersion= \
  -DgroupId=com.mycompany.hr \
  -DartifactId=holidayService
```

This command will create a new directory called `holidayService`. In this directory, there is a `'src/main/webapp'` directory, which will contain the root of the WAR file. You will find the standard web application deployment descriptor `'WEB-INF/web.xml'` here, which defines a Spring-WS `MessageDispatcherServlet` and maps all incoming requests to this servlet.

```
<web-app xmlns="http://java.sun.com/xml/ns/j2ee"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
             http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd"
         version="2.4">

    <display-name>MyCompany HR Holiday Service</display-name>

    <!-- take especial notice of the name of this servlet -->
    <servlet>
        <servlet-name>spring-ws</servlet-name>
        <servlet-class>org.springframework.ws.transport.http.MessageDispatcherServlet</
servlet-class>
    </servlet>

    <servlet-mapping>
        <servlet-name>spring-ws</servlet-name>
        <url-pattern>/*</url-pattern>
    </servlet-mapping>

</web-app>
```

In addition to the above `'WEB-INF/web.xml'` file, you will also need another, Spring-WS-specific configuration file, named `'WEB-INF/spring-ws-servlet.xml'`. This file contains all of the Spring-WS-specific beans such as `EndPoints`, `WebServiceMessageReceivers`, and suchlike, and is used to create a new Spring container. The name of this file is derived from the name of the attendant servlet (in this case `'spring-ws'`) with `'-servlet.xml'` appended to it. So if you defined a `MessageDispatcherServlet` with the name `'dynamite'`, the name of the Spring-WS-specific configuration file would be `'WEB-INF/dynamite-servlet.xml'`.

(You can see the contents of the `'WEB-INF/spring-ws-servlet.xml'` file for this example in ???.)

Once you had the project structure created, you can put the schema and wsdl from previous section into `'WEB-INF/'` folder.

3.6 Implementing the Endpoint

In Spring-WS, you will implement *Endpoints* to handle incoming XML messages. An endpoint is typically created by annotating a class with the `@Endpoint` annotation. In this endpoint class, you will create one or more methods that handle incoming request. The method signatures can be quite flexible: you can include just about any sort of parameter type related to the incoming XML message, as will be explained later.

Handling the XML Message

In this sample application, we are going to use JDom 2 to handle the XML message. We are also using XPath, because it allows us to select particular parts of the XML JDOM tree, without requiring strict schema conformance.

```
package com.mycompany.hr.ws;

import java.text.ParseException;
import java.text.SimpleDateFormat;
import java.util.Arrays;
import java.util.Date;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.ws.server.endpoint.annotation.Endpoint;
import org.springframework.ws.server.endpoint.annotation.PayloadRoot;
import org.springframework.ws.server.endpoint.annotation.RequestPayload;

import com.mycompany.hr.service.HumanResourceService;
import org.jdom2.Element;
import org.jdom2.JDOMException;
import org.jdom2.Namespace;
import org.jdom2.filter.Filters;
import org.jdom2.xpath.XPathExpression;
import org.jdom2.xpath.XPathFactory;

@Endpoint                                                                    ❶
public class HolidayEndpoint {

    private static final String NAMESPACE_URI = "http://mycompany.com/hr/schemas";

    private XPathExpression<Element> startDateExpression;

    private XPathExpression<Element> endDateExpression;

    private XPathExpression<Element> firstNameExpression;

    private XPathExpression<Element> lastNameExpression;

    private HumanResourceService humanResourceService;
                                                                             ❷
    @Autowired
    public HolidayEndpoint(HumanResourceService humanResourceService) throws JDOMException
 {
        this.humanResourceService = humanResourceService;

        Namespace namespace = Namespace.getNamespace("hr", NAMESPACE_URI);
        XPathFactory xPathFactory = XPathFactory.instance();
        startDateExpression = xPathFactory.compile("//hr:StartDate", Filters.element(),
 null, namespace);
        endDateExpression = xPathFactory.compile("//hr:EndDate", Filters.element(), null,
 namespace);
        firstNameExpression = xPathFactory.compile("//hr:FirstName", Filters.element(),
 null, namespace);
        lastNameExpression = xPathFactory.compile("//hr:LastName", Filters.element(),
 null, namespace);
    }

    @PayloadRoot(namespace = NAMESPACE_URI, localPart = "HolidayRequest")    ❸
    public void handleHolidayRequest(@RequestPayload Element holidayRequest) throws
 Excep❹tion {
        Date startDate = parseDate(startDateExpression, holidayRequest);
        Date endDate = parseDate(endDateExpression, holidayRequest);
        String name = firstNameExpression.evaluateFirst(holidayRequest).getText() + " " +
 lastNameExpression.evaluateFirst(holidayRequest).getText();

        humanResourceService.bookHoliday(startDate, endDate, name);
    }

    private Date parseDate(XPathExpression<Element> expression, Element element) throws
 ParseException {
        Element result = expression.evaluateFirst(element);
        if (result != null) {
            SimpleDateFormat dateFormat = new SimpleDateFormat("yyyy-MM-dd");
```

❶ The `HolidayEndpoint` is annotated with `@Endpoint`. This marks the class as a special sort of `@Component`, suitable for handling XML messages in Spring-WS, and also making it eligible for suitable for component scanning.

❷ The `HolidayEndpoint` requires the `HumanResourceService` business service to operate, so we inject the dependency via the constructor and annotate it with `@Autowired`.

Next, we set up XPath expressions using the JDOM2 API. There are four expressions: `//hr:StartDate` for extracting the `<StartDate>` text value, `//hr:EndDate` for extracting the end date and two for extracting the names of the employee.

❸ The `@PayloadRoot` annotation tells Spring-WS that the `handleHolidayRequest` method is suitable for handling XML messages. The sort of message that this method can handle is indicated by the annotation values, in this case, it can handle XML elements that have the `HolidayRequest` local part and the `http://mycompany.com/hr/schemas` namespace.

More information about mapping messages to endpoints is provided in the next section.

❹ The `handleHolidayRequest(..)` method is the main handling method method, which gets passed with the `<HolidayRequest/>` element from the incoming XML message. The `@RequestPayload` annotation indicates that the *`holidayRequest`* parameter should be mapped to the payload of the request message.

We use the XPath expressions to extract the string values from the XML messages, and convert these values to `Date` objects using a `SimpleDateFormat` (the `parseData` method).

With these values, we invoke a method on the business service. Typically, this will result in a database transaction being started, and some records being altered in the database.

Finally, we define a `void` return type, which indicates to Spring-WS that we do not want to send a response message. If we wanted a response message, we could have returned a JDOM Element that represents the payload of the response message.

Using JDOM is just one of the options to handle the XML: other options include DOM, dom4j, XOM, SAX, and StAX, but also marshalling techniques like JAXB, Castor, XMLBeans, JiBX, and XStream, as is explained in the next chapter. We chose JDOM because it gives us access to the raw XML, and because it is based on classes (not interfaces and factory methods as with W3C DOM and dom4j), which makes the code less verbose. We use XPath because it is less fragile than marshalling technologies: we don't care for strict schema conformance, as long as we can find the dates and the name.

Because we use JDOM, we must add some dependencies to the Maven `pom.xml`, which is in the root of our project directory. Here is the relevant section of the POM:

```
<dependencies>
    <dependency>
        <groupId>org.springframework.ws</groupId>
        <artifactId>spring-ws-core</artifactId>
        <version></version>
    </dependency>
    <dependency>
        <groupId>jdom</groupId>
        <artifactId>jdom</artifactId>
        <version>2.0.1</version>
    </dependency>
    <dependency>
        <groupId>jaxen</groupId>
        <artifactId>jaxen</artifactId>
        <version>1.1</version>
    </dependency>
</dependencies>
```

Here is how we would configure these classes in our `spring-ws-servlet.xml` Spring XML configuration file, by using component scanning. We also instruct Spring-WS to use annotation-driven endpoints, with the `<sws:annotation-driven>` element.

```
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:context="http://www.springframework.org/schema/context"
  xmlns:sws="http://www.springframework.org/schema/web-services"
  xsi:schemaLocation="http://www.springframework.org/schema/beans http://
www.springframework.org/schema/beans/spring-beans-3.0.xsd
  http://www.springframework.org/schema/web-services http://www.springframework.org/
schema/web-services/web-services-2.0.xsd
  http://www.springframework.org/schema/context http://www.springframework.org/schema/
context/spring-context-3.0.xsd">

  <context:component-scan base-package="com.mycompany.hr"/>

  <sws:annotation-driven/>

</beans>
```

Routing the Message to the Endpoint

As part of writing the endpoint, we also used the `@PayloadRoot` annotation to indicate which sort of messages can be handled by the `handleHolidayRequest` method. In Spring-WS, this process is the responsibility of an `EndpointMapping`. Here we route messages based on their content, by using a `PayloadRootAnnotationMethodEndpointMapping`. The annotation used above:

```
@PayloadRoot(namespace = "http://mycompany.com/hr/schemas", localPart = "HolidayRequest")
```

basically means that whenever an XML message is received with the namespace `http://mycompany.com/hr/schemas` and the `HolidayRequest` local name, it will be routed to the `handleHolidayRequest` method. By using the `<sws:annotation-driven>` element in our configuration, we enable the detection of the `@PayloadRoot` annotations. It is possible (and quite common) to have multiple, related handling methods in an endpoint, each of them handling different XML messages.

There are also other ways to map endpoints to XML messages, which will be described in the next chapter.

Providing the Service and Stub implementation

Now that we have the *Endpoint*, we need `HumanResourceService` and its implementation for use by `HolidayEndpoint`.

```
package com.mycompany.hr.service;

import java.util.Date;

public interface HumanResourceService {
    void bookHoliday(Date startDate, Date endDate, String name);
}
```

For tutorial purposes, we will use a simple stub implementation of the `HumanResourceService`.

```
package com.mycompany.hr.service;

import java.util.Date;

import org.springframework.stereotype.Service;

@Service                                                                    ❶
public class StubHumanResourceService implements HumanResourceService {
    public void bookHoliday(Date startDate, Date endDate, String name) {
        System.out.println("Booking holiday for [" + startDate + "-" + endDate + "] for ["
 + name + "] ");
    }
}
```

❶ The `StubHumanResourceService` is annotated with `@Service`. This marks the class as a business facade, which makes this a candidate for injection by `@Autowired` in `HolidayEndpoint`.

3.7 Publishing the WSDL

Finally, we need to publish the WSDL. As stated in Section 3.4, “Service contract”, we don't need to write a WSDL ourselves; Spring-WS can generate one for us based on some conventions. Here is how we define the generation:

```
<sws:dynamic-wsdl id="holiday"                                              ❶
    portTypeName="HumanResource"                                            ❸
    locationUri="/holidayService/"                                          ❹
    targetNamespace="http://mycompany.com/hr/definitions">                  ❺
  <sws:xsd location="/WEB-INF/hr.xsd"/>                                     ❷
</sws:dynamic-wsdl>
```

❶ The id determines the URL where the WSDL can be retrieved. In this case, the id is `holiday`, which means that the WSDL can be retrieved as `holiday.wsdl` in the servlet context. The full URL will typically be `http://localhost:8080/holidayService/holiday.wsdl`.

❸ Next, we set the WSDL port type to be `HumanResource`.

❹ We set the location where the service can be reached: `/holidayService/`. We use a relative URI and we instruct the framework to transform it dynamically to an absolute URI. Hence, if the service is deployed to different contexts we don't have to change the URI manually. For more information, please refer to the section called “Automatic WSDL exposure”

For the location transformation to work, we need to add an init parameter to `spring-ws` servlet in `web.xml`:

```
<init-param>
  <param-name>transformWsdlLocations</param-name>
  <param-value>true</param-value>
</init-param>
```

❺ We define the target namespace for the WSDL definition itself. Setting this attribute is not required. If not set, the WSDL will have the same namespace as the XSD schema.

❷ The `xsd` element refers to the human resource schema we defined in Section 3.3, “Data Contract”. We simply placed the schema in the `WEB-INF` directory of the application.

You can create a WAR file using **mvn install**. If you deploy the application (to Tomcat, Jetty, etc.), and point your browser at this location, you will see the generated WSDL. This WSDL is ready to be used by clients, such as soapUI, or other SOAP frameworks.

That concludes this tutorial. The tutorial code can be found in the full distribution of Spring-WS. The next step would be to look at the echo sample application that is part of the distribution. After that, look at the airline sample, which is a bit more complicated, because it uses JAXB, WS-Security, Hibernate, and a transactional service layer. Finally, you can read the rest of the reference documentation.

Part II. Reference

This part of the reference documentation details the various components that comprise Spring Web Services. This includes a chapter that discusses the parts common to both client- and server-side WS, a chapter devoted to the specifics of writing server-side Web services, a chapter about using Web services on the client-side, and a chapters on using WS-Security.

4. Shared components

In this chapter, we will explore the components which are shared between client- and server-side Spring-WS development. These interfaces and classes represent the building blocks of Spring-WS, so it is important to understand what they do, even if you do not use them directly.

4.1 Web service messages

`WebServiceMessage`

One of the core interfaces of Spring Web Services is the `WebServiceMessage`. This interface represents a protocol-agnostic XML message. The interface contains methods that provide access to the payload of the message, in the form of a `javax.xml.transform.Source` or a `javax.xml.transform.Result`. `Source` and `Result` are tagging interfaces that represent an abstraction over XML input and output. Concrete implementations wrap various XML representations, as indicated in the following table.

Source/Result implementation	Wraps XML representation
`javax.xml.transform.dom.DOMSource`	`org.w3c.dom.Node`
`javax.xml.transform.dom.DOMResult`	`org.w3c.dom.Node`
`javax.xml.transform.sax.SAXSource`	`org.xml.sax.InputSource` and `org.xml.sax.XMLReader`
`javax.xml.transform.sax.SAXResult`	`org.xml.sax.ContentHandler`
`javax.xml.transform.stream.StreamSource`	`java.io.File`, `java.io.InputStream`, or `java.io.Reader`
`javax.xml.transform.stream.StreamResult`	`java.io.File`, `java.io.OutputStream`, or `java.io.Writer`

In addition to reading from and writing to the payload, a Web service message can write itself to an output stream.

`SoapMessage`

The `SoapMessage` is a subclass of `WebServiceMessage`. It contains SOAP-specific methods, such as getting SOAP Headers, SOAP Faults, etc. Generally, your code should not be dependent on `SoapMessage`, because the content of the SOAP Body (the payload of the message) can be obtained via `getPayloadSource()` and `getPayloadResult()` in the `WebServiceMessage`. Only when it is necessary to perform SOAP-specific actions, such as adding a header, getting an attachment, etc., should you need to cast `WebServiceMessage` to `SoapMessage`.

Message Factories

Concrete message implementations are created by a `WebServiceMessageFactory`. This factory can create an empty message, or read a message based on an input stream. There are two concrete implementations of `WebServiceMessageFactory`; one is based on SAAJ, the SOAP with Attachments API for Java, the other based on Axis 2's AXIOM, the AXis Object Model.

`SaajSoapMessageFactory`

The `SaajSoapMessageFactory` uses the SOAP with Attachments API for Java to create `SoapMessage` implementations. SAAJ is part of J2EE 1.4, so it should be supported under most modern application servers. Here is an overview of the SAAJ versions supplied by common application servers:

Application Server	SAAJ Version
BEA WebLogic 8	1.1
BEA WebLogic 9	1.1/1.2[1]
IBM WebSphere 6	1.2
SUN Glassfish 1	1.3

[1] Weblogic 9 has a known bug in the SAAJ 1.2 implementation: it implement all the 1.2 interfaces, but throws a `UnsupportedOperationException` when called. Spring Web Services has a workaround: it uses SAAJ 1.1 when operating on WebLogic 9.

Additionally, Java SE 6 includes SAAJ 1.3. You wire up a `SaajSoapMessageFactory` like so:

```
<bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory" />
```

Note

SAAJ is based on DOM, the Document Object Model. This means that all SOAP messages are stored *in memory*. For larger SOAP messages, this may not be very performant. In that case, the `AxiomSoapMessageFactory` might be more applicable.

`AxiomSoapMessageFactory`

The `AxiomSoapMessageFactory` uses the AXis 2 Object Model to create `SoapMessage` implementations. AXIOM is based on StAX, the Streaming API for XML. StAX provides a pull-based mechanism for reading XML messages, which can be more efficient for larger messages.

To increase reading performance on the `AxiomSoapMessageFactory`, you can set the payloadCaching property to false (default is true). This will read the contents of the SOAP body directly from the socket stream. When this setting is enabled, the payload can only be read once. This means that you have to make sure that any pre-processing (logging etc.) of the message does not consume it.

You use the `AxiomSoapMessageFactory` as follows:

```
<bean id="messageFactory"
 class="org.springframework.ws.soap.axiom.AxiomSoapMessageFactory">
    <property name="payloadCaching" value="true"/>
</bean>
```

In addition to payload caching, AXIOM also supports full streaming messages, as defined in the `StreamingWebServiceMessage`. This means that the payload can be directly set on the response message, rather than being written to a DOM tree or buffer.

Full streaming for AXIOM is used when a handler method returns a JAXB2-supported object. It will automatically set this marshalled object into the response message, and write it out to the outgoing socket stream when the response is going out.

For more information about full streaming, refer to the class-level Javadoc for `StreamingWebServiceMessage` and `StreamingPayload`.

SOAP 1.1 or 1.2

Both the `SaajSoapMessageFactory` and the `AxiomSoapMessageFactory` have a soapVersion property, where you can inject a `SoapVersion` constant. By default, the version is 1.1, but you can set it to 1.2 like so:

```
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:util="http://www.springframework.org/schema/util"
       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-2.0.xsd
       http://www.springframework.org/schema/util
       http://www.springframework.org/schema/util/spring-util-2.0.xsd">

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory">
        <property name="soapVersion">
            <util:constant static-field="org.springframework.ws.soap.SoapVersion.SOAP_12"/
>
        </property>
    </bean>

</beans>
```

In the example above, we define a `SaajSoapMessageFactory` that only accepts SOAP 1.2 messages.

Caution

Even though both versions of SOAP are quite similar in format, the 1.2 version is not backwards compatible with 1.1 because it uses a different XML namespace. Other major differences between SOAP 1.1 and 1.2 include the different structure of a Fault, and the fact that `SOAPAction` HTTP headers are effectively deprecated, thought they still work.

One important thing to note with SOAP version numbers, or WS-* specification version numbers in general, is that the latest version of a specification is generally not the most popular version. For SOAP, this means that currently, the best version to use is 1.1. Version 1.2 might become more popular in the future, but currently 1.1 is the safest bet.

`MessageContext`

Typically, messages come in pairs: a request and a response. A request is created on the client-side, which is sent over some transport to the server-side, where a response is generated. This response gets sent back to the client, where it is read.

In Spring Web Services, such a conversation is contained in a `MessageContext`, which has properties to get request and response messages. On the client-side, the message context is created by the `WebServiceTemplate`. On the server-side, the message context is read from the transport-specific input stream. For example, in HTTP, it is read from the `HttpServletRequest` and the response is written back to the `HttpServletResponse`.

4.2 `TransportContext`

One of the key properties of the SOAP protocol is that it tries to be transport-agnostic. This is why, for instance, Spring-WS does not support mapping messages to endpoints by HTTP request URL, but rather by mesage content.

However, sometimes it is necessary to get access to the underlying transport, either on the client or server side. For this, Spring Web Services has the `TransportContext`. The transport context allows access to the underlying `WebServiceConnection`, which typically is a `HttpServletConnection` on the server side; or a `HttpUrlConnection` or `CommonsHttpConnection` on the client side. For example, you can obtain the IP address of the current request in a server-side endpoint or interceptor like so:

```
TransportContext context = TransportContextHolder.getTransportContext();
HttpServletConnection connection = (HttpServletConnection )context.getConnection();
HttpServletRequest request = connection.getHttpServletRequest();
String ipAddress = request.getRemoteAddr();
```

4.3 Handling XML With XPath

One of the best ways to handle XML is to use XPath. Quoting [effective-xml], item 35:

> XPath is a fourth generation declarative language that allows you to specify which nodes you want to process without specifying exactly how the processor is supposed to navigate to those nodes. XPath's data model is very well designed to support exactly what almost all developers want from XML. For instance, it merges all adjacent text including that in CDATA sections, allows values to be calculated that skip over comments and processing instructions` and include text from child and descendant elements, and requires all external entity references to be resolved. In practice, XPath expressions tend to be much more robust against unexpected but perhaps insignificant changes in the input document.
>
> —Elliotte Rusty Harold

Spring Web Services has two ways to use XPath within your application: the faster `XPathExpression` or the more flexible `XPathTemplate`.

`XPathExpression`

The `XPathExpression` is an abstraction over a compiled XPath expression, such as the Java 5 `javax.xml.xpath.XPathExpression`, or the Jaxen `XPath` class. To construct an expression in an application context, there is the `XPathExpressionFactoryBean`. Here is an example which uses this factory bean:

```
<beans xmlns="http://www.springframework.org/schema/beans"
       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-2.0.xsd">

    <bean id="nameExpression"
 class="org.springframework.xml.xpath.XPathExpressionFactoryBean">
        <property name="expression" value="/Contacts/Contact/Name"/>
    </bean>

    <bean id="myEndpoint" class="sample.MyXPathClass">
        <constructor-arg ref="nameExpression"/>
    </bean>

</beans>
```

The expression above does not use namespaces, but we could set those using the namespaces property of the factory bean. The expression can be used in the code as follows:

```
package sample;

public class MyXPathClass {

    private final XPathExpression nameExpression;

    public MyXPathClass(XPathExpression nameExpression) {
        this.nameExpression = nameExpression;
    }

    public void doXPath(Document document) {
        String name = nameExpression.evaluateAsString(document.getDocumentElement());
        System.out.println("Name: " + name);
    }

}
```

For a more flexible approach, you can use a `NodeMapper`, which is similar to the `RowMapper` in Spring's JDBC support. The following example shows how we can use it:

```
package sample;

public class MyXPathClass  {

   private final XPathExpression contactExpression;

   public MyXPathClass(XPathExpression contactExpression) {
      this.contactExpression = contactExpression;
   }

   public void doXPath(Document document) {
      List contacts = contactExpression.evaluate(document,
        new NodeMapper() {
           public Object mapNode(Node node, int nodeNum) throws DOMException {
              Element contactElement = (Element) node;
              Element nameElement = (Element)
 contactElement.getElementsByTagName("Name").item(0);
              Element phoneElement = (Element)
 contactElement.getElementsByTagName("Phone").item(0);
              return new Contact(nameElement.getTextContent(),
 phoneElement.getTextContent());
           }
        });
      // do something with list of Contact objects
   }
}
```

Similar to mapping rows in Spring JDBC's `RowMapper`, each result node is mapped using an anonymous inner class. In this case, we create a `Contact` object, which we use later on.

`XPathTemplate`

The `XPathExpression` only allows you to evaluate a single, pre-compiled expression. A more flexible, though slower, alternative is the `XpathTemplate`. This class follows the common template pattern used throughout Spring (JdbcTemplate, JmsTemplate, etc.). Here is an example:

```
package sample;

public class MyXPathClass {

    private XPathOperations template = new Jaxp13XPathTemplate();

    public void doXPath(Source source) {
        String name = template.evaluateAsString("/Contacts/Contact/Name", request);
        // do something with name
    }

}
```

4.4 Message Logging and Tracing

When developing or debugging a Web service, it can be quite useful to look at the content of a (SOAP) message when it arrives, or just before it is sent. Spring Web Services offer this functionality, via the standard Commons Logging interface.

Caution

Make sure to use Commons Logging version 1.1 or higher. Earlier versions have class loading issues, and do not integrate with the Log4J TRACE level.

To log all server-side messages, simply set the `org.springframework.ws.server.MessageTracing` logger to level DEBUG or TRACE. On the debug level, only the payload root element is logged; on the TRACE level, the entire message content. If you only want to log sent messages, use the `org.springframework.ws.server.MessageTracing.sent` logger; or `org.springframework.ws.server.MessageTracing.received` to log received messages.

On the client-side, similar loggers exist: `org.springframework.ws.client.MessageTracing.sent` and `org.springframework.ws.client.MessageTracing.received`.

Here is an example `log4j.properties` configuration, logging the full content of sent messages on the client side, and only the payload root element for client-side received messages. On the server-side, the payload root is logged for both sent and received messages:

```
log4j.rootCategory=INFO, stdout
log4j.logger.org.springframework.ws.client.MessageTracing.sent=TRACE
log4j.logger.org.springframework.ws.client.MessageTracing.received=DEBUG

log4j.logger.org.springframework.ws.server.MessageTracing=DEBUG

log4j.appender.stdout=org.apache.log4j.ConsoleAppender
log4j.appender.stdout.layout=org.apache.log4j.PatternLayout
log4j.appender.stdout.layout.ConversionPattern=%p [%c{3}] %m%n
```

With this configuration, a typical output will be:

```
TRACE [client.MessageTracing.sent] Sent request [<SOAP-ENV:Envelope xmlns:SOAP-ENV="...
DEBUG [server.MessageTracing.received] Received request [SaajSoapMessage {http://
example.com}request] ...
DEBUG [server.MessageTracing.sent] Sent response [SaajSoapMessage {http://
example.com}response] ...
DEBUG [client.MessageTracing.received] Received response [SaajSoapMessage {http://
example.com}response] ...
```

5. Creating a Web service with Spring-WS

5.1 Introduction

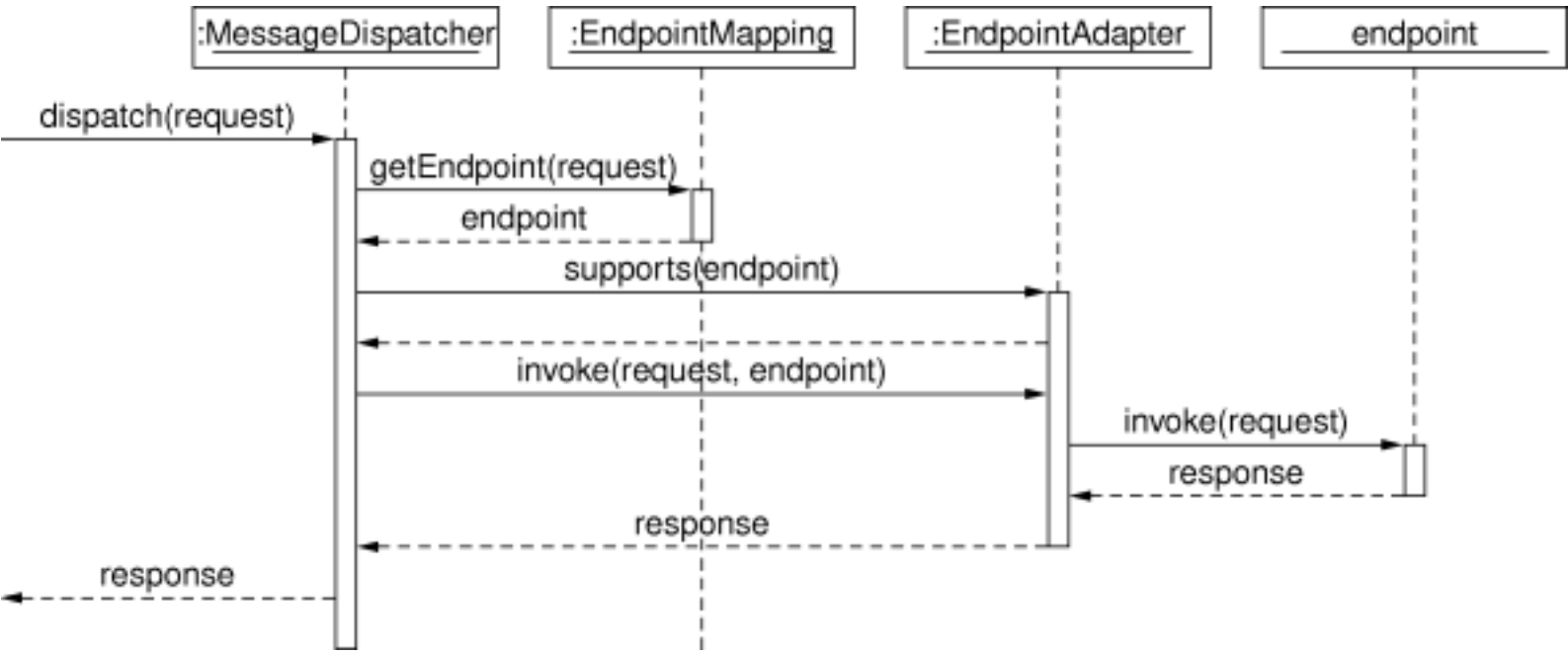
Spring-WS's server-side support is designed around a `MessageDispatcher` that dispatches incoming messages to endpoints, with configurable endpoint mappings, response generation, and endpoint interception. Endpoints are typically annotated with the `@Endpoint` annotation, and have one or more handling methods. These methods handle incoming XML request messages by inspecting parts of the message (typically the payload), and create some sort of response. You annotate the method with another annotation, typically `@PayloadRoot`, to indicate what sort of messages it can handle.

Spring-WS's XML handling is extremely flexible. An endpoint can choose from a large amount of XML handling libraries supported by Spring-WS, including the DOM family (W3C DOM, JDOM, dom4j, and XOM), SAX or StAX for faster performance, XPath to extract information from the message, or even marshalling techniques (JAXB, Castor, XMLBeans, JiBX, or XStream) to convert the XML to objects and vice-versa.

5.2 The `MessageDispatcher`

The server-side of Spring-WS is designed around a central class that dispatches incoming XML messages to endpoints. Spring-WS's `MessageDispatcher` is extremely flexible, allowing you to use any sort of class as an endpoint, as long as it can be configured in the Spring IoC container. In a way, the message dispatcher resembles Spring's `DispatcherServlet`, the “Front Controller” used in Spring Web MVC.

The processing and dispatching flow of the `MessageDispatcher` is illustrated in the following sequence diagram.



The request processing workflow in Spring Web Services

When a `MessageDispatcher` is set up for use and a request comes in for that specific dispatcher, said `MessageDispatcher` starts processing the request. The list below describes the complete process a request goes through when handled by a `MessageDispatcher`:

1. An appropriate endpoint is searched for using the configured `EndpointMapping(s)`. If an endpoint is found, the invocation chain associated with the endpoint (pre-processors, post-processors, and endpoints) will be executed in order to create a response.

2. An appropriate adapter is searched for the endpoint. The `MessageDispatcher` delegates to this adapter to invoke the endpoint.

3. If a response is returned, it is sent on its way. If no response is returned (which could be due to a pre- or post-processor intercepting the request, for example, for security reasons), no response is sent.

Exceptions that are thrown during handling of the request get picked up by any of the endpoint exception resolvers that are declared in the application context. Using these exception resolvers allows you to define custom behaviors (such as returning a SOAP Fault) in case such exceptions get thrown.

The `MessageDispatcher` has several properties, for setting endpoint adapters, mappings, exception resolvers. However, setting these properties is not required, since the dispatcher will automatically detect all of these types that are registered in the application context. Only when detection needs to be overriden, should these properties be set.

The message dispatcher operates on a message context, and not transport-specific input stream and output stream. As a result, transport specific requests need to read into a `MessageContext`. For HTTP, this is done with a `WebServiceMessageReceiverHandlerAdapter`, which is a Spring Web `HandlerInterceptor`, so that the `MessageDispatcher` can be wired in a standard `DispatcherServlet`. There is a more convenient way to do this, however, which is shown in the section called “`MessageDispatcherServlet`”.

5.3 Transports

Spring Web Services supports multiple transport protocols. The most common is the HTTP transport, for which a custom servlet is supplied, but it is also possible to send messages over JMS, and even email.

`MessageDispatcherServlet`

The `MessageDispatcherServlet` is a standard `Servlet` which conveniently extends from the standard Spring Web `DispatcherServlet`, and wraps a `MessageDispatcher`. As such, it combines the attributes of these into one: as a `MessageDispatcher`, it follows the same request handling flow as described in the previous section. As a servlet, the `MessageDispatcherServlet` is configured in the `web.xml` of your web application. Requests that you want the `MessageDispatcherServlet` to handle will have to be mapped using a URL mapping in the same `web.xml` file. This is standard Java EE servlet configuration; an example of such a `MessageDispatcherServlet` declaration and mapping can be found below.

```
<web-app>

    <servlet>
        <servlet-name>spring-ws</servlet-name>
        <servlet-class>org.springframework.ws.transport.http.MessageDispatcherServlet</
servlet-class>
        <load-on-startup>1</load-on-startup>
    </servlet>

    <servlet-mapping>
        <servlet-name>spring-ws</servlet-name>
        <url-pattern>/*</url-pattern>
    </servlet-mapping>

</web-app>
```

In the example above, all requests will be handled by the `'spring-ws' MessageDispatcherServlet`. This is only the first step in setting up Spring Web Services, because the various component beans used by the Spring-WS framework also need to be configured; this configuration consists of standard Spring XML `<bean/>` definitions. Because the `MessageDispatcherServlet` is a standard Spring `DispatcherServlet`, it will *look for a file named `[servlet-name]-servlet.xml`* in the `WEB-INF` directory of your web application and create the beans defined there in a Spring container. In the example above, that means that it looks for '`/WEB-INF/spring-ws-servlet.xml`'. This file will contain all of the Spring Web Services beans such as endpoints, marshallers and suchlike.

As an alternative for `web.xml`, if you are running on a Servlet 3+ environment, you can configure Spring-WS programmatically. For this purpose, Spring-WS provides a number of abstract base classes that extend the `WebApplicationInitializer` interface found in the Spring Framework. If you are also using `@Configuration` classes for your bean definitions, you are best of extending the `AbstractAnnotationConfigMessageDispatcherServletInitializer`, like so:

```
public class MyServletInitializer
    extends AbstractAnnotationConfigMessageDispatcherServletInitializer {

    @Override
    protected Class<?>[] getRootConfigClasses() {
        return new Class[]{MyRootConfig.class};
    }

    @Override
    protected Class<?>[] getServletConfigClasses() {
        return new Class[]{MyEndpointConfig.class};
    }

}
```

In the example above, we tell Spring that endpoint bean definitions can be found in the `MyEndpointConfig` class (which is a `@Configuration` class). Other bean definitions (typically services, repositories, etc.) can be found in the `MyRootConfig` class. By default, the `AbstractAnnotationConfigMessageDispatcherServletInitializer` maps the servlet to two patterns: `/services` and `*.wsdl`, though this can be changed by overriding the `getServletMappings()` method. For more details on the programmatic configuration of the `MessageDispatcherServlet`, refer to the Javadoc of `AbstractMessageDispatcherServletInitializer` and `AbstractAnnotationConfigMessageDispatcherServletInitializer`.

Automatic WSDL exposure

The `MessageDispatcherServlet` will automatically detect any `WsdlDefinition` beans defined in it's Spring container. All such `WsdlDefinition` beans that are detected will also be exposed via a `WsdlDefinitionHandlerAdapter`; this is a very convenient way to expose your WSDL to clients simply by just defining some beans.

By way of an example, consider the following `<static-wsdl>`definition, defined in the Spring-WS configuration file (`/WEB-INF/[servlet-name]-servlet.xml`). Take notice of the value of the '`id`' attribute, because this will be used when exposing the WSDL.

```
<sws:static-wsdl id="orders" location="orders.wsdl"/>
```

Or as `@Bean` method in a `@Configuration` class:

```
@Bean
public SimpleWsdl11Definition orders() {
 return new SimpleWsdl11Definition(new ClassPathResource("orders.xml"));
}
```

The WSDL defined in the '`orders.wsdl`' file on the classpath can then be accessed via `GET` requests to a URL of the following form (substitute the host, port and servlet context path as appropriate).

```
http://localhost:8080/spring-ws/orders.wsdl
```

Note

All `WsdlDefinition` bean definitions are exposed by the `MessageDispatcherServlet` under their bean name with the suffix `.wsdl`. So if the bean name is `echo`, the host name is "server", and the Servlet context (war name) is "spring-ws", the WSDL can be obtained via `http://server/spring-ws/echo.wsdl`

Another nice feature of the `MessageDispatcherServlet` (or more correctly the `WsdlDefinitionHandlerAdapter`) is that it is able to transform the value of the '`location`' of all the WSDL that it exposes to reflect the URL of the incoming request.

Please note that this '`location`' transformation feature is *off* by default.To switch this feature on, you just need to specify an initialization parameter to the `MessageDispatcherServlet`, like so:

```
<web-app>

  <servlet>
    <servlet-name>spring-ws</servlet-name>
    <servlet-class>org.springframework.ws.transport.http.MessageDispatcherServlet</
servlet-class>
    <init-param>
      <param-name>transformWsdlLocations</param-name>
      <param-value>true</param-value>
    </init-param>
  </servlet>

  <servlet-mapping>
    <servlet-name>spring-ws</servlet-name>
    <url-pattern>/*</url-pattern>
  </servlet-mapping>

</web-app>
```

If you use the `AbstractAnnotationConfigMessageDispatcherServletInitializer`, enabling transformation is as simple as overriding the `isTransformWsdlLocations()` method to return `true`.

Consult the class-level Javadoc on the `WsdlDefinitionHandlerAdapter` class to learn more about the whole transformation process.

As an alternative to writing the WSDL by hand, and exposing it with `<static-wsdl>`, Spring Web Services can also generate a WSDL from an XSD schema. This is the approach shown in Section 3.7, “Publishing the WSDL”. The next application context snippet shows how to create such a dynamic WSDL file:

```
<sws:dynamic-wsdl id="orders"
    portTypeName="Orders"
    locationUri="http://localhost:8080/ordersService/">
  <sws:xsd location="Orders.xsd"/>
</sws:dynamic-wsdl>
```

Or, as `@Bean` method:

```
@Bean
public DefaultWsdl11Definition orders() {
    DefaultWsdl11Definition definition = new DefaultWsdl11Definition();
    definition.setPortTypeName("Orders");
    definition.setLocationUri("http://localhost:8080/ordersService/");
    definition.setSchema(new SimpleXsdSchema(new ClassPathResource("echo.xsd")));

    return definition;
}
```

The `<dynamic-wsdl>` element depends on the `DefaultWsdl11Definition` class. This definition class uses WSDL providers in the org.springframework.ws.wsdl.wsdl11.provider package and the `ProviderBasedWsdl4jDefinition` to generate a WSDL the first time it is requested. Refer to the class-level Javadoc of these classes to see how you can extend this mechanism, if necessary.

The `DefaultWsdl11Definition` (and therefore, the `<dynamic-wsdl>` tag) builds a WSDL from a XSD schema by using conventions. It iterates over all `element` elements found in the schema, and creates a `message` for all elements. Next, it creates WSDL `operation` for all messages that end with the defined request or response suffix. The default request suffix is `Request`; the default response suffix is `Response`, though these can be changed by setting the requestSuffix and responseSuffix attributes on `<dynamic-wsdl />`, respectively. It also builds a `portType`, `binding`, and `service` based on the operations.

For instance, if our `Orders.xsd` schema defines the `GetOrdersRequest` and `GetOrdersResponse` elements, `<dynamic-wsdl>` will create a `GetOrdersRequest` and `GetOrdersResponse` message, and a `GetOrders` operation, which is put in a `Orders` port type.

If you want to use multiple schemas, either by includes or imports, you will want to put Commons XMLSchema on the class path. If Commons XMLSchema is on the class path, the above `<dynamic-wsdl>` element will follow all XSD imports and includes, and will inline them in the WSDL as a single XSD. This greatly simplifies the deployment of the schemas, which still making it possible to edit them separately.

Caution

Even though it can be quite handy to create the WSDL at runtime from your XSDs, there are a couple of drawbacks to this approach. First off, though we try to keep the WSDL generation process consistent between releases, there is still the possibility that it changes (slightly). Second, the generation is a bit slow, though once generated, the WSDL is cached for later reference.

It is therefore recommended to only use `<dynamic-wsdl>` during the development stages of your project. Then, we recommend to use your browser to download the generated WSDL, store it in the project, and expose it with `<static-wsdl>`. This is the only way to be really sure that the WSDL does not change over time.

Wiring up Spring-WS in a `DispatcherServlet`

As an alternative to the `MessageDispatcherServlet`, you can wire up a `MessageDispatcher` in a standard, Spring-Web MVC `DispatcherServlet`. By default, the `DispatcherServlet` can only delegate to `Controllers`, but we can instruct it to delegate to a `MessageDispatcher` by adding a `WebServiceMessageReceiverHandlerAdapter` to the servlet's web application context:

```
<beans>

    <bean
 class="org.springframework.ws.transport.http.WebServiceMessageReceiverHandlerAdapter"/>

    <bean class="org.springframework.web.servlet.handler.SimpleUrlHandlerMapping">
        <property name="defaultHandler" ref="messageDispatcher"/>
    </bean

    <bean id="messageDispatcher"
 class="org.springframework.ws.soap.server.SoapMessageDispatcher"/>

    ...

    <bean
 class="org.springframework.web.servlet.mvc.method.annotation.RequestMappingHandlerAdapter"/
>

</beans>
```

Note that by explicitly adding the `WebServiceMessageReceiverHandlerAdapter`, the dispatcher servlet does not load the default adapters, and is unable to handle standard Spring-MVC `@Controllers`. Therefore, we add the `RequestMappingHandlerAdapter` at the end.

In a similar fashion, you can wire up a `WsdlDefinitionHandlerAdapter` to make sure the `DispatcherServlet` can handle implementations of the `WsdlDefinition` interface:

```
<beans>

    <bean
 class="org.springframework.ws.transport.http.WebServiceMessageReceiverHandlerAdapter"/>

    <bean class="org.springframework.ws.transport.http.WsdlDefinitionHandlerAdapter"/>

    <bean class="org.springframework.web.servlet.handler.SimpleUrlHandlerMapping">
        <property name="mappings">
           <props>
             <prop key="*.wsdl">myServiceDefinition</prop>
           </props>
        </property>
        <property name="defaultHandler" ref="messageDispatcher"/>
    </bean>

    <bean id="messageDispatcher"
 class="org.springframework.ws.soap.server.SoapMessageDispatcher"/>

    <bean id="myServiceDefinition"
 class="org.springframework.ws.wsdl.wsdl11.SimpleWsdl11Definition">
       <prop name="wsdl" value="/WEB-INF/myServiceDefintion.wsdl"/>
    </bean>

    ...

</beans>
```

JMS transport

Spring Web Services supports server-side JMS handling through the JMS functionality provided in the Spring framework. Spring Web Services provides the `WebServiceMessageListener` to plug in to a `MessageListenerContainer`. This message listener requires a `WebServiceMessageFactory` to and `MessageDispatcher` to operate. The following piece of configuration shows this:

```
<beans>

    <bean id="connectionFactory" class="org.apache.activemq.ActiveMQConnectionFactory">
        <property name="brokerURL" value="vm://localhost?broker.persistent=false"/>
    </bean>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean class="org.springframework.jms.listener.DefaultMessageListenerContainer">
        <property name="connectionFactory" ref="connectionFactory"/>
        <property name="destinationName" value="RequestQueue"/>
        <property name="messageListener">
            <bean class="org.springframework.ws.transport.jms.WebServiceMessageListener">
                <property name="messageFactory" ref="messageFactory"/>
                <property name="messageReceiver" ref="messageDispatcher"/>
            </bean>
        </property>
    </bean>

    <bean id="messageDispatcher"
 class="org.springframework.ws.soap.server.SoapMessageDispatcher">
        <property name="endpointMappings">
            <bean

 class="org.springframework.ws.server.endpoint.mapping.PayloadRootAnnotationMethodEndpointMapping">
                <property name="defaultEndpoint">
                    <bean class="com.example.MyEndpoint"/>
                </property>
            </bean>
        </property>
    </bean>
</beans>
```

Email transport

In addition to HTTP and JMS, Spring Web Services also provides server-side email handling. This functionality is provided through the `MailMessageReceiver` class. This class monitors a POP3 or IMAP folder, converts the email to a `WebServiceMessage`, sends any response using SMTP. The host names can be configured through the storeUri, which indicates the mail folder to monitor for requests (typically a POP3 or IMAP folder), and a transportUri, which indicates the server to use for sending responses (typically a SMTP server).

How the `MailMessageReceiver` monitors incoming messages can be configured with a pluggable strategy: the `MonitoringStrategy`. By default, a polling strategy is used, where the incoming folder is polled for new messages every five minutes. This interval can be changed by setting the pollingInterval property on the strategy. By default, all `MonitoringStrategy` implementations delete the handled messages; this can be changed by setting the deleteMessages property.

As an alternative to the polling approaches, which are quite inefficient, there is a monitoring strategy that uses IMAP **IDLE**. The **IDLE** command is an optional expansion of the IMAP email protocol that allows the mail server to send new message updates to the `MailMessageReceiver` asynchronously. If you use a IMAP server that supports the **IDLE** command, you can plug in the `ImapIdleMonitoringStrategy` into the monitoringStrategy property. In addition to a supporting server, you will need to use JavaMail version 1.4.1 or higher.

The following piece of configuration shows how to use the server-side email support, overiding the default polling interval to a value which checks every 30 seconds (30.000 milliseconds):

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="messagingReceiver"
 class="org.springframework.ws.transport.mail.MailMessageReceiver">
        <property name="messageFactory" ref="messageFactory"/>
        <property name="from" value="Spring-WS SOAP Server &lt;server@example.com&gt;"/>
        <property name="storeUri" value="imap://server:s04p@imap.example.com/INBOX"/>
        <property name="transportUri" value="smtp://smtp.example.com"/>
        <property name="messageReceiver" ref="messageDispatcher"/>
        <property name="monitoringStrategy">
            <bean
 class="org.springframework.ws.transport.mail.monitor.PollingMonitoringStrategy">
                <property name="pollingInterval" value="30000"/>
            </bean>
        </property>
    </bean>

    <bean id="messageDispatcher"
 class="org.springframework.ws.soap.server.SoapMessageDispatcher">
        <property name="endpointMappings">
            <bean

 class="org.springframework.ws.server.endpoint.mapping.PayloadRootAnnotationMethodEndpointMapping">
                <property name="defaultEndpoint">
                    <bean class="com.example.MyEndpoint"/>
                </property>
            </bean>
        </property>
    </bean>
</beans>
```

Embedded HTTP Server transport

Spring Web Services provides a transport based on Sun's JRE 1.6 HTTP server. The embedded HTTP Server is a standalone server that is simple to configure. It lends itself to a lighter alternative to conventional servlet containers.

When using the embedded HTTP server, no external deployment descriptor is needed (`web.xml`). You only need to define an instance of the server and configure it to handle incoming requests. The remoting module in the Core Spring Framework contains a convenient factory bean for the HTTP server: the `SimpleHttpServerFactoryBean`. The most important property is contexts, which maps context paths to corresponding `HttpHandlers`.

Spring Web Services provides 2 implementations of the `HttpHandler` interface: `WsdlDefinitionHttpHandler` and `WebServiceMessageReceiverHttpHandler`. The former maps an incoming GET request to a `WsdlDefinition`. The latter is responsible for handling POST requests for web services messages and thus needs a `WebServiceMessageFactory` (typically a `SaajSoapMessageFactory`) and a `WebServiceMessageReceiver` (typically the `SoapMessageDispatcher`) to accomplish its task.

To draw parallels with the servlet world, the contexts property plays the role of servlet mappings in `web.xml` and the `WebServiceMessageReceiverHttpHandler` is the equivalent of a `MessageDispatcherServlet`.

The following snippet shows a simple configuration example of the HTTP server transport:

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="messageReceiver"
 class="org.springframework.ws.soap.server.SoapMessageDispatcher">
        <property name="endpointMappings" ref="endpointMapping"/>
    </bean>

    <bean id="endpointMapping"
 class="org.springframework.ws.server.endpoint.mapping.PayloadRootAnnotationMethodEndpointMapping">
        <property name="defaultEndpoint" ref="stockEndpoint"/>
    </bean>

    <bean id="httpServer"
 class="org.springframework.remoting.support.SimpleHttpServerFactoryBean">
        <property name="contexts">
            <map>
                <entry key="/StockService.wsdl" value-ref="wsdlHandler"/>
                <entry key="/StockService" value-ref="soapHandler"/>
            </map>
        </property>
    </bean>

    <bean id="soapHandler"
 class="org.springframework.ws.transport.http.WebServiceMessageReceiverHttpHandler">
        <property name="messageFactory" ref="messageFactory"/>
        <property name="messageReceiver" ref="messageReceiver"/>
    </bean>

    <bean id="wsdlHandler"
 class="org.springframework.ws.transport.http.WsdlDefinitionHttpHandler">
        <property name="definition" ref="wsdlDefinition"/>
    </bean>
</beans>
```

For more information on the `SimpleHttpServerFactoryBean`, refer to the Javadoc.

XMPP transport

Finally, Spring Web Services 2.0 introduced support for XMPP, otherwise known as Jabber. The support is based on the Smack library.

Spring Web Services support for XMPP is very similar to the other transports: there is a a `XmppMessageSender` for the `WebServiceTemplate` and and a `XmppMessageReceiver` to use with the `MessageDispatcher`.

The following example shows how to set up the server-side XMPP components:

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="connection"
 class="org.springframework.ws.transport.xmpp.support.XmppConnectionFactoryBean">
        <property name="host" value="jabber.org"/>
        <property name="username" value="username"/>
        <property name="password" value="password"/>
    </bean>

    <bean id="messagingReceiver"
 class="org.springframework.ws.transport.xmpp.XmppMessageReceiver">
        <property name="messageFactory" ref="messageFactory"/>
        <property name="connection" ref="connection"/>
        <property name="messageReceiver" ref="messageDispatcher"/>
    </bean>

    <bean id="messageDispatcher"
 class="org.springframework.ws.soap.server.SoapMessageDispatcher">
        <property name="endpointMappings">
            <bean

 class="org.springframework.ws.server.endpoint.mapping.PayloadRootAnnotationMethodEndpointMapping">
                <property name="defaultEndpoint">
                    <bean class="com.example.MyEndpoint"/>
                </property>
            </bean>
        </property>
    </bean>

</beans>
```

MTOM

MTOM is the mechanism of sending binary data to and from Web Services. You can look at how to implement this with Spring WS through the MTOM sample.

5.4 Endpoints

Endpoints are the central concept in Spring-WS's server-side support. Endpoints provide access to the application behavior which is typically defined by a business service interface. An endpoint interprets the XML request message and uses that input to invoke a method on the business service (typically). The result of that service invocation is represented as a response message. Spring-WS has a wide variety of endpoints, using various ways to handle the XML message, and to create a response.

You create an endpoint by annotating a class with the `@Endpoint` annotation. In the class, you define one or more methods that handle the incoming XML request, by using a wide variety of parameter types (such as DOM elements, JAXB2 objects, etc). You indicate the sort of messages a method can handle by using another annotation (typically `@PayloadRoot`).

Consider the following sample endpoint:

```
package samples;

import org.w3c.dom.Element;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.ws.server.endpoint.annotation.Endpoint;
import org.springframework.ws.server.endpoint.annotation.PayloadRoot;
import org.springframework.ws.soap.SoapHeader;

@Endpoint                                                                    ❶
public class AnnotationOrderEndpoint {

  private final OrderService orderService;

  @Autowired                                                                 ❷
  public AnnotationOrderEndpoint(OrderService orderService) {
      this.orderService = orderService;
  }

  @PayloadRoot(localPart = "order", namespace = "http://samples")            ❺
  public void order(@RequestPayload Element orderElement) {                  ❸
    Order order = createOrder(orderElement);
    orderService.createOrder(order);
  }

  @PayloadRoot(localPart = "orderRequest", namespace = "http://samples")     ❺
  @ResponsePayload
  public Order getOrder(@RequestPayload OrderRequest orderRequest, SoapHeader header) {  ❹
    checkSoapHeaderForSomething(header);
    return orderService.getOrder(orderRequest.getId());
  }

  ...

}
```

❶ The class is annotated with `@Endpoint`, marking it as a Spring-WS endpoint.

❷ The constructor is marked with `@Autowired`, so that the `OrderService` business service is injected into this endpoint.

❸ The `order` method takes a `Element` as a parameter, annotated with `@RequestPayload`. This means that the payload of the message is passed on this method as a DOM element. The method has a `void` return type, indicating that no response message is sent.

For more information about endpoint methods, refer to the section called “`@Endpoint` handling methods”.

❹ The `getOrder` method takes a `OrderRequest` as a parameter, annotated with `@RequestPayload` as well. This parameter is a JAXB2-supported object (it is annotated with `@XmlRootElement`). This means that the payload of the message is passed on to this method as a unmarshalled object. The `SoapHeader` type is also given as a parameter. On invocation, this parameter will contain the SOAP header of the request message. The method is also annotated with `@ResponsePayload`, indicating that the return value (the `Order`) is used as the payload of the response message.

For more information about endpoint methods, refer to the section called “`@Endpoint` handling methods”.

❺ The two handling methods of this endpoint are marked with `@PayloadRoot`, indicating what sort of request messages can be handled by the method: the `getOrder` method will be invoked for requests with a `orderRequest` local name and a `http://samples` namespace URI; the `order` method for requests with a `order` local name.

For more information about `@PayloadRoot`, refer to Section 5.5, “Endpoint mappings”.

To enable the support for `@Endpoint` and related Spring-WS annotations, you will need to add the following to your Spring application context:

```
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:sws="http://www.springframework.org/schema/web-services"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
      http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/web-services
      http://www.springframework.org/schema/web-services/web-services.xsd">

  <sws:annotation-driven />

</beans>
```

Or, if you are using `@Configuration` classes instead of Spring XML, you can annotate your configuration class with `@EnableWs`, like so:

```
@EnableWs
@Configuration
public class EchoConfig {

    // @Bean definitions go here

}
```

To customize the `@EnableWs` configuration, you can implement `WsConfigurer`, or better yet extend the `WsConfigurerAdapter`. For instance:

```
@Configuration
@EnableWs
@ComponentScan(basePackageClasses = { MyConfiguration.class })
public class MyConfiguration extends WsConfigurerAdapter {

  @Override
  public void addInterceptors(List<EndpointInterceptor> interceptors) {
    interceptors.add(new MyInterceptor());
  }

  @Override
  public void addArgumentResolvers(List<MethodArgumentResolver> argumentResolvers) {
    argumentResolvers.add(new MyArgumentResolver());
  }

  // More overridden methods ...
}
```

In the next couple of sections, a more elaborate description of the `@Endpoint` programming model is given.

Note

Endpoints, like any other Spring Bean, are scoped as a singleton by default, i.e. one instance of the bean definition is created per container. Being a singleton implies that more than one thread can use it at the same time, so the endpoint has to be thread safe. If you want to use a different scope, such as prototype, refer to the Spring Reference documentation.

Note that all abstract base classes provided in Spring-WS are thread safe, unless otherwise indicated in the class-level Javadoc.

`@Endpoint` handling methods

In order for an endpoint to actually handle incoming XML messages, it needs to have one or more handling methods. Handling methods can take wide range of parameters and return types, but typically they have one parameter that will contain the message payload, and they return the payload of the response message (if any). You will learn which parameter and return types are supported in this section.

To indicate what sort of messages a method can handle, the method is typically annotated with either the `@PayloadRoot` or `@SoapAction` annotation. You will learn more about these annotations in Section 5.5, “Endpoint mappings”.

Here is an example of a handling method:

```
@PayloadRoot(localPart = "order", namespace = "http://samples")
public void order(@RequestPayload Element orderElement) {
  Order order = createOrder(orderElement);
  orderService.createOrder(order);
}
```

The `order` method takes a `Element` as a parameter, annotated with `@RequestPayload`. This means that the payload of the message is passed on this method as a DOM element. The method has a `void` return type, indicating that no response message is sent.

Handling method parameters

The handling method typically has one or more parameters that refer to various parts of the incoming XML message. Most commonly, the handling method will have a single parameter that will map to the payload of the message, but it is also possible to map to other parts of the request message, such as a SOAP header. This section will describe the parameters you can use in your handling method signatures.

To map a parameter to the payload of the request message, you will need to annotate this parameter with the `@RequestPayload` annotation. This annotation tells Spring-WS that the parameter needs to be bound to the request payload.

The following table describes the supported parameter types. It shows the supported types, whether the parameter should be annotated with `@RequestPayload`, and any additional notes.

Name	Supported parameter types	`@RequestPayload` required?	Additional notes
TrAX	`javax.xml.transform.Source` and sub-interfaces (`DOMSource`, `SAXSource`,	Yes	Enabled by default.

Name	Supported parameter types	@RequestPayload required?	Additional notes
	`StreamSource`, and `StAXSource`)		
W3C DOM	`org.w3c.dom.Element`	Yes	Enabled by default
dom4j	`org.dom4j.Element`	Yes	Enabled when dom4j is on the classpath.
JDOM	`org.jdom.Element`	Yes	Enabled when JDOM is on the classpath.
XOM	`nu.xom.Element`	Yes	Enabled when XOM is on the classpath.
StAX	`javax.xml.stream.XMLStreamReader` and `javax.xml.stream.XMLEventReader`	Yes	Enabled when StAX is on the classpath.
XPath	Any boolean, double, `String`, `org.w3c.Node`, `org.w3c.dom.NodeList`, or type that can be converted from a `String` by a Spring 3 conversion service, and that is annotated with `@XPathParam`.	No	Enabled by default, see the section called "`@XPathParam`".
Message context	`org.springframework.ws.context.MessageContext`	No	Enabled by default.
SOAP	`org.springframework.ws.soap.SoapMessage`, `org.springframework.ws.soap.SoapBody`, `org.springframework.ws.soap.SoapEnvelope`, `org.springframework.ws.soap.SoapHeader`, and `org.springframework.ws.soap.SoapHeaderElements` when used in combination with the `@SoapHeader` annotation.	No	Enabled by default.
JAXB2	Any type that is annotated with `javax.xml.bind.annotation.XmlRootElement`, and `javax.xml.bind.JAXBElement`.	Yes	Enabled when JAXB2 is on the classpath.
OXM	Any type supported by a Spring OXM `Unmarshaller`.	Yes	Enabled when the `unmarshaller` attribute of

Name	Supported parameter types	@RequestPayload required?	Additional notes
			`<sws:annotation-driven/>` is specified.

Here are some examples of possible method signatures:

- ```
  public void handle(@RequestPayload Element element)
  ```
  This method will be invoked with the payload of the request message as a DOM `org.w3c.dom.Element`.

- ```
  public void handle(@RequestPayload DOMSource domSource, SoapHeader header)
  ```
  This method will be invoked with the payload of the request message as a `javax.xml.transform.dom.DOMSource`. The *`header`* parameter will be bound to the SOAP header of the request message.

- ```
  public void handle(@RequestPayload MyJaxb2Object requestObject, @RequestPayload Element
   element, Message messageContext)
  ```
  This method will be invoked with the payload of the request message unmarshalled into a `MyJaxb2Object` (which is annotated with `@XmlRootElement`). The payload of the message is also given as a DOM `Element`. The whole message context is passed on as the third parameter.

As you can see, there are a lot of possibilities when it comes to defining handling method signatures. It is even possible to extend this mechanism, and to support your own parameter types. Refer to the class-level Javadoc of `DefaultMethodEndpointAdapter` and `MethodArgumentResolver` to see how.

`@XPathParam`

One parameter type needs some extra explanation: `@XPathParam`. The idea here is that you simply annotate one or more method parameter with an XPath expression, and that each such annotated parameter will be bound to the evaluation of the expression. Here is an example:
  ```

```
package samples;

import javax.xml.transform.Source;

import org.springframework.ws.server.endpoint.annotation.Endpoint;
import org.springframework.ws.server.endpoint.annotation.Namespace;
import org.springframework.ws.server.endpoint.annotation.PayloadRoot;
import org.springframework.ws.server.endpoint.annotation.XPathParam;

@Endpoint
public class AnnotationOrderEndpoint {

  private final OrderService orderService;

  public AnnotationOrderEndpoint(OrderService orderService) {
    this.orderService = orderService;
  }

  @PayloadRoot(localPart = "orderRequest", namespace = "http://samples")
  @Namespace(prefix = "s", uri="http://samples")
  public Order getOrder(@XPathParam("/s:orderRequest/@id") int orderId) {
    Order order = orderService.getOrder(orderId);
    // create Source from order and return it
}

}
```

Since we use the prefix 's' in our XPath expression, we must bind it to the `http://samples` namespace. This is accomplished with the `@Namespace` annotation. Alternatively, we could have placed this annotation on the type-level to use the same namespace mapping for all handler methods, or even the package-level (in `package-info.java`) to use it for multiple endpoints.

Using the `@XPathParam`, you can bind to all the data types supported by XPath:

- boolean or `Boolean`
- double or `Double`
- `String`
- `Node`
- `NodeList`

In addition to this list, you can use any type that can be converted from a `String` by a Spring 3 conversion service.

Handling method return types

To send a response message, the handling needs to specify a return type. If no response message is required, the method can simply declare a `void` return type. Most commonly, the return type is used to create the payload of the response message, but it is also possible to map to other parts of the response message. This section will describe the return types you can use in your handling method signatures.

To map the return value to the payload of the response message, you will need to annotate the method with the `@ResponsePayload` annotation. This annotation tells Spring-WS that the return value needs to be bound to the response payload.

The following table describes the supported return types. It shows the supported types, whether the parameter should be annotated with `@ResponsePayload`, and any additional notes.

Name	Supported return types	@ResponsePayload required?	Additional notes
No response	`void`	No	Enabled by default.
TrAX	`javax.xml.transform.Source` and sub-interfaces (`DOMSource`, `SAXSource`, `StreamSource`, and `StAXSource`)	Yes	Enabled by default.
W3C DOM	`org.w3c.dom.Element`	Yes	Enabled by default
dom4j	`org.dom4j.Element`	Yes	Enabled when dom4j is on the classpath.
JDOM	`org.jdom.Element`	Yes	Enabled when JDOM is on the classpath.
XOM	`nu.xom.Element`	Yes	Enabled when XOM is on the classpath.
JAXB2	Any type that is annotated with `javax.xml.bind.annotation.XmlRootElement`, and `javax.xml.bind.JAXBElement`.	Yes	Enabled when JAXB2 is on the classpath.
OXM	Any type supported by a Spring OXM `Marshaller`.	Yes	Enabled when the `marshaller` attribute of `<sws:annotation-driven/>` is specified.

As you can see, there are a lot of possibilities when it comes to defining handling method signatures. It is even possible to extend this mechanism, and to support your own parameter types. Refer to the class-level Javadoc of `DefaultMethodEndpointAdapter` and `MethodReturnValueHandler` to see how.

5.5 Endpoint mappings

The endpoint mapping is responsible for mapping incoming messages to appropriate endpoints. There are some endpoint mappings that are enabled out of the box, for example, the `PayloadRootAnnotationMethodEndpointMapping` or the `SoapActionAnnotationMethodEndpointMapping`, but let's first examine the general concept of an `EndpointMapping`.

An `EndpointMapping` delivers a `EndpointInvocationChain`, which contains the endpoint that matches the incoming request, and may also contain a list of endpoint interceptors that will be applied to the request and response. When a request comes in, the `MessageDispatcher` will hand it over to the endpoint mapping to let it inspect the request and come up with an appropriate

`EndpointInvocationChain`. Then the `MessageDispatcher` will invoke the endpoint and any interceptors in the chain.

The concept of configurable endpoint mappings that can optionally contain interceptors (which can manipulate the request or the response, or both) is extremely powerful. A lot of supporting functionality can be built into custom `EndpointMappings`. For example, there could be a custom endpoint mapping that chooses an endpoint not only based on the contents of a message, but also on a specific SOAP header (or indeed multiple SOAP headers).

Most endpoint mappings inherit from the `AbstractEndpointMapping`, which offers an 'interceptors' property, which is the list of interceptors to use. `EndpointInterceptors` are discussed in the section called “Intercepting requests - the `EndpointInterceptor` interface”. Additionally, there is the 'defaultEndpoint', which is the default endpoint to use when this endpoint mapping does not result in a matching endpoint.

As explained in Section 5.4, “Endpoints”, the `@Endpoint` style allows you to handle multiple requests in one endpoint class. This is the responsibility of the `MethodEndpointMapping`. This mapping determines which method is to be invoked for an incoming request message.

There are two endpoint mappings that can direct requests to methods: the `PayloadRootAnnotationMethodEndpointMapping` and the `SoapActionAnnotationMethodEndpointMapping`, both of which are enabled by using `<sws:annotation-driven/>` in your application context.

The `PayloadRootAnnotationMethodEndpointMapping` uses the `@PayloadRoot` annotation, with the `localPart` and `namespace` elements, to mark methods with a particular qualified name. Whenever a message comes in which has this qualified name for the payload root element, the method will be invoked. For an example, see above.

Alternatively, the `SoapActionAnnotationMethodEndpointMapping` uses the `@SoapAction` annotation to mark methods with a particular SOAP Action. Whenever a message comes in which has this `SOAPAction` header, the method will be invoked.

WS-Addressing

WS-Addressing specifies a transport-neutral routing mechanism. It is based on a `To` and `Action` SOAP header, which indicate the destination and intent of the SOAP message, respectively. Additionally, WS-Addressing allows you to define a return address (for normal messages and for faults), and a unique message identifier which can be used for correlation [11]. Here is an example of a WS-Addressing message:

[11] For more information on WS-Addressing, see http://en.wikipedia.org/wiki/WS-Addressing.

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://www.w3.org/2003/05/soap-envelope"
    xmlns:wsa="http://www.w3.org/2005/08/addressing">
  <SOAP-ENV::Header>
    <wsa:MessageID>urn:uuid:21363e0d-2645-4eb7-8afd-2f5ee1bb25cf</wsa:MessageID>
    <wsa:ReplyTo>
      <wsa:Address>http://example.com/business/client1</wsa:Address>
    </wsa:ReplyTo>
    <wsa:To S:mustUnderstand="true">http://example/com/fabrikam</wsa:To>
    <wsa:Action>http://example.com/fabrikam/mail/Delete</wsa:Action>
  </SOAP-ENV:Header>
  <SOAP-ENV:Body>
    <f:Delete xmlns:f="http://example.com/fabrikam">
      <f:maxCount>42</f:maxCount>
    </f:Delete>
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

In this example, the destination is set to `http://example/com/fabrikam`, while the action is set to `http://example.com/fabrikam/mail/Delete`. Additionally, there is a message identifier, and an reply-to address. By default, this address is the "anonymous" address, indicating that a response should be sent using the same channel as the request (i.e. the HTTP response), but it can also be another address, as indicated in this example.

In Spring Web Services, WS-Addressing is implemented as an endpoint mapping. Using this mapping, you associate WS-Addressing actions with endpoints, similar to the `SoapActionAnnotationMethodEndpointMapping` described above.

`AnnotationActionEndpointMapping`

The `AnnotationActionEndpointMapping` is similar to the `SoapActionAnnotationMethodEndpointMapping`, but uses WS-Addressing headers instead of the SOAP Action transport header.

To use the `AnnotationActionEndpointMapping`, annotate the handling methods with the `@Action` annotation, similar to the `@PayloadRoot` and `@SoapAction` annotations described in the section called “`@Endpoint` handling methods” and Section 5.5, “Endpoint mappings”. Here is an example:

```
package samples;

import org.springframework.ws.server.endpoint.annotation.Endpoint;
import org.springframework.ws.soap.addressing.server.annotation.Action

@Endpoint
public class AnnotationOrderEndpoint {
    private final OrderService orderService;

    public AnnotationOrderEndpoint(OrderService orderService) {
        this.orderService = orderService;
    }

    @Action("http://samples/RequestOrder")
    public Order getOrder(OrderRequest orderRequest) {
        return orderService.getOrder(orderRequest.getId());
    }

    @Action("http://samples/CreateOrder")
    public void order(Order order) {
        orderService.createOrder(order);
    }

}
```

The mapping above routes requests which have a WS-Addressing `Action` of `http://samples/RequestOrder` to the `getOrder` method. Requests with `http://samples/CreateOrder` will be routed to the `order` method..

By default, the `AnnotationActionEndpointMapping` supports both the 1.0 (May 2006), and the August 2004 editions of WS-Addressing. These two versions are most popular, and are interoperable with Axis 1 and 2, JAX-WS, XFire, Windows Communication Foundation (WCF), and Windows Services Enhancements (WSE) 3.0. If necessary, specific versions of the spec can be injected into the versions property.

In addition to the `@Action` annotation, you can annotate the class with the `@Address` annotation. If set, the value is compared to the `To` header property of the incoming message.

Finally, there is the messageSenders property, which is required for sending response messages to non-anonymous, out-of-bound addresses. You can set `MessageSender` implementations in this property, the same as you would on the `WebServiceTemplate`. See the section called “URIs and Transports”.

Intercepting requests - the `EndpointInterceptor` interface

The endpoint mapping mechanism has the notion of endpoint interceptors. These can be extremely useful when you want to apply specific functionality to certain requests, for example, dealing with security-related SOAP headers, or the logging of request and response message.

Endpoint interceptors are typically defined by using a `<sws:interceptors>` element in your application context. In this element, you can simply define endpoint interceptor beans that apply to all endpoints defined in that application context. Alternatively, you can use `<sws:payloadRoot>` or `<sws:soapAction>` elements to specify for which payload root name or SOAP action the interceptor should apply. For example:

```
<sws:interceptors>
  <bean class="samples.MyGlobalInterceptor"/>
  <sws:payloadRoot namespaceUri="http://www.example.com">
    <bean class="samples.MyPayloadRootInterceptor"/>
  </sws:payloadRoot>
  <sws:soapAction value="http://www.example.com/SoapAction">
    <bean class="samples.MySoapActionInterceptor1"/>
    <ref bean="mySoapActionInterceptor2"/>
  </sws:soapAction>
</sws:interceptors>

<bean id="mySoapActionInterceptor2" class="samples.MySoapActionInterceptor2"/>
```

Here, we define one 'global' interceptor (`MyGlobalInterceptor`) that intercepts all request and responses. We also define an interceptor that only applies to XML messages that have the `http://www.example.com` as a payload root namespace. Here, we could have defined a `localPart` attribute in addition to the `namespaceUri` to further limit the messages the interceptor applies to. Finally, we define two interceptors that apply when the message has a `http://www.example.com/SoapAction` SOAP action. Notice how the second interceptor is actually a reference to a bean definition outside of the `<interceptors>` element. You can use bean references anywhere inside the `<interceptors>` element.

When using `@Configuration` classes, you can extend from `WsConfigurerAdapter` to add interceptors. Like so:

```
@Configuration
@EnableWs
public class MyWsConfiguration extends WsConfigurerAdapter {

  @Override
  public void addInterceptors(List<EndpointInterceptor> interceptors) {
    interceptors.add(new MyPayloadRootInterceptor());
  }

}
```

Interceptors must implement the `EndpointInterceptor` interface from the org.springframework.ws.server package. This interface defines three methods, one that can be used for handling the request message *before* the actual endpoint will be executed, one that can be used for handling a normal response message, and one that can be used for handling fault messages, both of which will be called *after* the endpoint is executed. These three methods should provide enough flexibility to do all kinds of pre- and post-processing.

The `handleRequest(..)` method on the interceptor returns a boolean value. You can use this method to interrupt or continue the processing of the invocation chain. When this method returns `true`, the endpoint execution chain will continue, when it returns `false`, the `MessageDispatcher` interprets this to mean that the interceptor itself has taken care of things and does not continue executing the other interceptors and the actual endpoint in the invocation chain. The `handleResponse(..)` and `handleFault(..)` methods also have a boolean return value. When these methods return `false`, the response will not be sent back to the client.

There are a number of standard `EndpointInterceptor` implementations you can use in your Web service. Additionally, there is the `XwsSecurityInterceptor`, which is described in Section 7.2, “ `XwsSecurityInterceptor` ”.

`PayloadLoggingInterceptor` and `SoapEnvelopeLoggingInterceptor`

When developing a Web service, it can be useful to log the incoming and outgoing XML messages. SWS facilitates this with the `PayloadLoggingInterceptor` and `SoapEnvelopeLoggingInterceptor` classes. The former logs just the payload of the message to the Commons Logging Log; the latter logs the entire SOAP envelope, including SOAP headers. The following example shows you how to define them in an endpoint mapping:

```
 <sws:interceptors>
   <bean
class="org.springframework.ws.server.endpoint.interceptor.PayloadLoggingInterceptor"/>
 </sws:interceptors>
```

Both of these interceptors have two properties: 'logRequest' and 'logResponse', which can be set to `false` to disable logging for either request or response messages.

Of course, you could use the `WsConfigurerAdapter` approach, as described above, for the `PayloadLoggingInterceptor` as well.

`PayloadValidatingInterceptor`

One of the benefits of using a contract-first development style is that we can use the schema to validate incoming and outgoing XML messages. Spring-WS facilitates this with the `PayloadValidatingInterceptor`. This interceptor requires a reference to one or more W3C XML or RELAX NG schemas, and can be set to validate requests or responses, or both.

Note

Note that request validation may sound like a good idea, but makes the resulting Web service very strict. Usually, it is not really important whether the request validates, only if the endpoint can get sufficient information to fullfill a request. Validating the response *is* a good idea, because the endpoint should adhere to its schema. Remember Postel's Law: “Be conservative in what you do; be liberal in what you accept from others.”

Here is an example that uses the `PayloadValidatingInterceptor`; in this example, we use the schema in `/WEB-INF/orders.xsd` to validate the response, but not the request. Note that the `PayloadValidatingInterceptor` can also accept multiple schemas using the schemas property.

```
<bean id="validatingInterceptor"

 class="org.springframework.ws.soap.server.endpoint.interceptor.PayloadValidatingInterceptor">
    <property name="schema" value="/WEB-INF/orders.xsd"/>
    <property name="validateRequest" value="false"/>
    <property name="validateResponse" value="true"/>
</bean>
```

Of course, you could use the `WsConfigurerAdapter` approach, as described above, for the `PayloadValidatingInterceptor` as well.

`PayloadTransformingInterceptor`

To transform the payload to another XML format, Spring Web Services offers the `PayloadTransformingInterceptor`. This endpoint interceptor is based on XSLT style sheets,

and is especially useful when supporting multiple versions of a Web service: you can transform the older message format to the newer format. Here is an example to use the `PayloadTransformingInterceptor`:

```
<bean id="transformingInterceptor"

 class="org.springframework.ws.server.endpoint.interceptor.PayloadTransformingInterceptor">
    <property name="requestXslt" value="/WEB-INF/oldRequests.xslt"/>
    <property name="responseXslt" value="/WEB-INF/oldResponses.xslt"/>
</bean>
```

We are simply transforming requests using `/WEB-INF/oldRequests.xslt`, and response messages using `/WEB-INF/oldResponses.xslt`. Note that, since endpoint interceptors are registered at the endpoint mapping level, you can simply create a endpoint mapping that applies to the "old style" messages, and add the interceptor to that mapping. Hence, the transformation will apply only to these "old style" message.

Of course, you could use the `WsConfigurerAdapter` approach, as described above, for the `PayloadTransformingInterceptor` as well.

5.6 Handling Exceptions

Spring-WS provides `EndpointExceptionResolvers` to ease the pain of unexpected exceptions occurring while your message is being processed by an endpoint which matched the request. Endpoint exception resolvers somewhat resemble the exception mappings that can be defined in the web application descriptor `web.xml`. However, they provide a more flexible way to handle exceptions. They provide information about what endpoint was invoked when the exception was thrown. Furthermore, a programmatic way of handling exceptions gives you many more options for how to respond appropriately. Rather than expose the innards of your application by giving an exception and stack trace, you can handle the exception any way you want, for example by returning a SOAP fault with a specific fault code and string.

Endpoint exception resolvers are automatically picked up by the `MessageDispatcher`, so no explicit configuration is necessary.

Besides implementing the `EndpointExceptionResolver` interface, which is only a matter of implementing the `resolveException(MessageContext, endpoint, Exception)` method, you may also use one of the provided implementations. The simplest implementation is the `SimpleSoapExceptionResolver`, which just creates a SOAP 1.1 Server or SOAP 1.2 Receiver Fault, and uses the exception message as the fault string. The `SimpleSoapExceptionResolver` is the default, but it can be overriden by explicitly adding another resolver.

SoapFaultMappingExceptionResolver

The `SoapFaultMappingExceptionResolver` is a more sophisticated implementation. This resolver enables you to take the class name of any exception that might be thrown and map it to a SOAP Fault, like so:

```
<beans>
    <bean id="exceptionResolver"

 class="org.springframework.ws.soap.server.endpoint.SoapFaultMappingExceptionResolver">
        <property name="defaultFault" value="SERVER"/>
        <property name="exceptionMappings">
            <value>
                org.springframework.oxm.ValidationFailureException=CLIENT,Invalid request
            </value>
        </property>
    </bean>
</beans>
```

The key values and default endpoint use the format `faultCode,faultString,locale`, where only the fault code is required. If the fault string is not set, it will default to the exception message. If the language is not set, it will default to English. The above configuration will map exceptions of type `ValidationFailureException` to a client-side SOAP Fault with a fault string `"Invalid request"`, as can be seen in the following response:

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
    <SOAP-ENV:Body>
       <SOAP-ENV:Fault>
           <faultcode>SOAP-ENV:Client</faultcode>
           <faultstring>Invalid request</faultstring>
       </SOAP-ENV:Fault>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

If any other exception occurs, it will return the default fault: a server-side fault with the exception message as fault string.

`SoapFaultAnnotationExceptionResolver`

Finally, it is also possible to annotate exception classes with the `@SoapFault` annotation, to indicate the SOAP Fault that should be returned whenever that exception is thrown. In order for these annotations to be picked up, you need to add the `SoapFaultAnnotationExceptionResolver` to your application context. The elements of the annotation include a fault code enumeration, fault string or reason, and language. Here is an example exception:

```
package samples;

import org.springframework.ws.soap.server.endpoint.annotation.FaultCode;
import org.springframework.ws.soap.server.endpoint.annotation.SoapFault;

@SoapFault(faultCode = FaultCode.SERVER)
public class MyBusinessException extends Exception {

    public MyClientException(String message) {
        super(message);
    }
}
```

Whenever the `MyBusinessException` is thrown with the constructor string `"Oops!"` during endpoint invocation, it will result in the following response:

```
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
    <SOAP-ENV:Body>
       <SOAP-ENV:Fault>
           <faultcode>SOAP-ENV:Server</faultcode>
           <faultstring>Oops!</faultstring>
       </SOAP-ENV:Fault>
    </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

5.7 Server-side testing

When it comes to testing your Web service endpoints, there are two possible approaches:

- Write *Unit Tests*, where you provide (mock) arguments for your endpoint to consume.

  The advantage of this approach is that it's quite easy to accomplish (especially for classes annotated with `@Endpoint`); the disadvantage is that you are not really testing the exact content of the XML messages that are sent over the wire.

- Write *Integrations Tests*, which do test the contents of the message.

The first approach can easily be accomplished with mocking frameworks such as EasyMock, JMock, etc. The next section will focus on writing integration tests, using the test features introduced in Spring Web Services 2.0.

Writing server-side integration tests

Spring Web Services 2.0 introduced support for creating endpoint integration tests. In this context, an endpoint is class handles (SOAP) messages (see Section 5.4, “Endpoints”).

The integration test support lives in the org.springframework.ws.test.server package. The core class in that package is the `MockWebServiceClient`. The underlying idea is that this client creates a request message, and then sends it over to the endpoint(s) that are configured in a standard `MessageDispatcherServlet` application context (see the section called “`MessageDispatcherServlet`”). These endpoints will handle the message, and create a response. The client then receives this response, and verifies it against registered expectations.

The typical usage of the `MockWebServiceClient` is:

1. Create a `MockWebServiceClient` instance by calling `MockWebServiceClient.createClient(ApplicationContext)` or `MockWebServiceClient.createClient(WebServiceMessageReceiver, WebServiceMessageFactory)`.

2. Send request messages by calling `sendRequest(RequestCreator)`, possibly by using the default `RequestCreator` implementations provided in `RequestCreators` (which can be statically imported).

3. Set up response expectations by calling `andExpect(ResponseMatcher)`, possibly by using the default `ResponseMatcher` implementations provided in `ResponseMatchers` (which can be statically imported). Multiple expectations can be set up by chaining `andExpect(ResponseMatcher)` calls.

Note

Note that the `MockWebServiceClient` (and related classes) offers a 'fluent' API, so you can typically use the Code Completion features (i.e. ctrl-space) in your IDE to guide you through the process of setting up the mock server.

Note

Also note that you rely on the standard logging features available in Spring Web Services in your unit tests. Sometimes it might be useful to inspect the request or response message to find out why a particular tests failed. See Section 4.4, “Message Logging and Tracing” for more information.

Consider, for example, this simple Web service endpoint class:

```
import org.springframework.ws.server.endpoint.annotation.Endpoint;
import org.springframework.ws.server.endpoint.annotation.RequestPayload;
import org.springframework.ws.server.endpoint.annotation.ResponsePayload;

@Endpoint                                                                    ❶
public class CustomerEndpoint {

  @ResponsePayload                                                           ❷
  public CustomerCountResponse getCustomerCount(                             ❷
      @RequestPayload CustomerCountRequest request) {                        ❷
    CustomerCountResponse response = new CustomerCountResponse();
    response.setCustomerCount(10);
    return response;
  }

}
```

❶ The `CustomerEndpoint` in annotated with `@Endpoint`. See Section 5.4, “Endpoints”.

❷ The `getCustomerCount()` method takes a `CustomerCountRequest` as argument, and returns a `CustomerCountResponse`. Both of these classes are objects supported by a marshaller. For instance, they can have a `@XmlRootElement` annotation to be supported by JAXB2.

A typical test for `CustomerEndpoint` would look like this:

```
import javax.xml.transform.Source;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.ApplicationContext;
import org.springframework.test.context.ContextConfiguration;
import org.springframework.test.context.junit4.SpringJUnit4ClassRunner;
import org.springframework.xml.transform.StringSource;

import org.junit.Before;
import org.junit.Test;
import org.junit.runner.RunWith;

import org.springframework.ws.test.server.MockWebServiceClient;                    ❶
import static org.springframework.ws.test.server.RequestCreators.*;                ❶
import static org.springframework.ws.test.server.ResponseMatchers.*;               ❶

@RunWith(SpringJUnit4ClassRunner.class)                                            ❷
@ContextConfiguration("spring-ws-servlet.xml")                                     ❷
public class CustomerEndpointIntegrationTest {

  @Autowired
  private ApplicationContext applicationContext;                                   ❸

  private MockWebServiceClient mockClient;

  @Before
  public void createClient() {
    mockClient = MockWebServiceClient.createClient(applicationContext);            ❹
  }

  @Test
  public void customerEndpoint() throws Exception {
    Source requestPayload = new StringSource(
      "<customerCountRequest xmlns='http://springframework.org/spring-ws'>" +
        "<customerName>John Doe</customerName>" +
      "</customerCountRequest>");
    Source responsePayload = new StringSource(
      "<customerCountResponse xmlns='http://springframework.org/spring-ws'>" +
        "<customerCount>10</customerCount>" +
      "</customerCountResponse>");

    mockClient.sendRequest(withPayload(requestPayload)).                           ❺
      andExpect(payload(responsePayload));                                         ❺
  }
}
```

❶ The `CustomerEndpointIntegrationTest` imports the `MockWebServiceClient`, and statically imports `RequestCreators` and `ResponseMatchers`.

❷ This test uses the standard testing facilities provided in the Spring Framework. This is not required, but is generally the easiest way to set up the test.

❸ The application context is a standard Spring-WS application context (see the section called "`MessageDispatcherServlet`"), read from `spring-ws-servlet.xml`. In this case, the application context will contain a bean definition for `CustomerEndpoint` (or a perhaps a `<context:component-scan />` is used).

❹ In a `@Before` method, we create a `MockWebServiceClient` by using the `createClient` factory method.

❺ We send a request by calling `sendRequest()` with a `withPayload()` `RequestCreator` provided by the statically imported `RequestCreators` (see the section called “`RequestCreator` and `RequestCreators`”).

We also set up response expectations by calling `andExpect()` with a `payload()` `ResponseMatcher` provided by the statically imported `ResponseMatchers` (see the section called “`ResponseMatcher` and `ResponseMatchers`”).

This part of the test might look a bit confusing, but the Code Completion features of your IDE are of great help. After typing `sendRequest(`, simply type ctrl-space, and your IDE will provide you with a list of possible request creating strategies, provided you statically imported `RequestCreators`. The same applies to `andExpect(`, provided you statically imported `ResponseMatchers`.

`RequestCreator` and `RequestCreators`

Initially, the `MockWebServiceClient` will need to create a request message for the endpoint to consume. The client uses the `RequestCreator` strategy interface for this purpose:

```
public interface RequestCreator {

  WebServiceMessage createRequest(WebServiceMessageFactory messageFactory)
    throws IOException;

}
```

You can write your own implementations of this interface, creating a request message by using the message factory, but you certainly do not have to. The `RequestCreators` class provides a way to create a `RequestCreator` based on a given payload in the `withPayload()` method. You will typically statically import `RequestCreators`.

`ResponseMatcher` and `ResponseMatchers`

When the request message has been processed by the endpoint, and a response has been received, the `MockWebServiceClient` can verify whether this response message meets certain expectations. The client uses the `ResponseMatcher` strategy interface for this purpose:

```
public interface ResponseMatcher {

    void match(WebServiceMessage request,
               WebServiceMessage response)
      throws IOException, AssertionError;

}
```

Once again you can write your own implementations of this interface, throwing `AssertionErrors` when the message does not meet your expectations, but you certainly do not have to, as the `ResponseMatchers` class provides standard `ResponseMatcher` implementations for you to use in your tests. You will typically statically import this class.

The `ResponseMatchers` class provides the following response matchers:

`ResponseMatchers` method	Description
`payload()`	Expects a given response payload.

`ResponseMatchers` method	Description
`validPayload()`	Expects the response payload to validate against given XSD schema(s).
`xpath()`	Expects a given XPath expression to exist, not exist, or evaluate to a given value.
`soapHeader()`	Expects a given SOAP header to exist in the response message.
`noFault()`	Expects that the response message does not contain a SOAP Fault.
`mustUnderstandFault()`, `clientOrSenderFault()`, `serverOrReceiverFault()`, and `versionMismatchFault()`	Expects the response message to contain a specific SOAP Fault.

You can set up multiple response expectations by chaining `andExpect()` calls, like so:

```
mockClient.sendRequest(...).
 andExpect(payload(expectedResponsePayload)).
 andExpect(validPayload(schemaResource));
```

For more information on the response matchers provided by `ResponseMatchers`, refer to the class level Javadoc.

6. Using Spring Web Services on the Client

6.1 Introduction

Spring-WS provides a client-side Web service API that allows for consistent, XML-driven access to Web services. It also caters for the use of marshallers and unmarshallers so that your service tier code can deal exclusively with Java objects.

The org.springframework.ws.client.core package provides the core functionality for using the client-side access API. It contains template classes that simplify the use of Web services, much like the core Spring `JdbcTemplate` does for JDBC. The design principle common to Spring template classes is to provide helper methods to perform common operations, and for more sophisticated usage, delegate to user implemented callback interfaces. The Web service template follows the same design. The classes offer various convenience methods for the sending and receiving of XML messages, marshalling objects to XML before sending, and allows for multiple transport options.

6.2 Using the client-side API

`WebServiceTemplate`

The `WebServiceTemplate` is the core class for client-side Web service access in Spring-WS. It contains methods for sending `Source` objects, and receiving response messages as either `Source` or `Result`. Additionally, it can marshal objects to XML before sending them across a transport, and unmarshal any response XML into an object again.

URIs and Transports

The `WebServiceTemplate` class uses an URI as the message destination. You can either set a defaultUri property on the template itself, or supply an URI explicitly when calling a method on the template. The URI will be resolved into a `WebServiceMessageSender`, which is responsible for sending the XML message across a transport layer. You can set one or more message senders using the messageSender or messageSenders properties of the `WebServiceTemplate` class.

HTTP transports

There are two implementations of the `WebServiceMessageSender` interface for sending messages via HTTP. The default implementation is the `HttpUrlConnectionMessageSender`, which uses the facilities provided by Java itself. The alternative is the `HttpComponentsMessageSender`, which uses the Apache HttpComponents HttpClient. Use the latter if you need more advanced and easy-to-use functionality (such as authentication, HTTP connection pooling, and so forth).

To use the HTTP transport, either set the defaultUri to something like `http://example.com/services`, or supply the *`uri`* parameter for one of the methods.

The following example shows how the default configuration can be used for HTTP transports:

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="webServiceTemplate"
 class="org.springframework.ws.client.core.WebServiceTemplate">
        <constructor-arg ref="messageFactory"/>
        <property name="defaultUri" value="http://example.com/WebService"/>
    </bean>

</beans>
```

The following example shows how override the default configuration, and to use Apache HttpClient to authenticate using HTTP authentication:

```
<bean id="webServiceTemplate"
 class="org.springframework.ws.client.core.WebServiceTemplate">
    <constructor-arg ref="messageFactory"/>
    <property name="messageSender">
        <bean class="org.springframework.ws.transport.http.HttpComponentsMessageSender">
            <property name="credentials">
                <bean class="org.apache.http.auth.UsernamePasswordCredentials">
                    <constructor-arg value="john:secret"/>
                </bean>
            </property>
        </bean>
    </property>
    <property name="defaultUri" value="http://example.com/WebService"/>
</bean>
```

JMS transport

For sending messages over JMS, Spring Web Services provides the `JmsMessageSender`. This class uses the facilities of the Spring framework to transform the `WebServiceMessage` into a JMS `Message`, send it on its way on a `Queue` or `Topic`, and receive a response (if any).

To use the `JmsMessageSender`, you need to set the defaultUri or *`uri`* parameter to a JMS URI, which - at a minimum - consists of the `jms:` prefix and a destination name. Some examples of JMS URIs are: `jms:SomeQueue`, `jms:SomeTopic?priority=3&deliveryMode=NON_PERSISTENT`, and `jms:RequestQueue?replyToName=ResponseName`. For more information on this URI syntax, refer to the class level Javadoc of the `JmsMessageSender`.

By default, the `JmsMessageSender` send JMS `BytesMessage`, but this can be overriden to use `TextMessages` by using the `messageType` parameter on the JMS URI. For example: `jms:Queue?messageType=TEXT_MESSAGE`. Note that `BytesMessages` are the preferred type, because `TextMessages` do not support attachments and character encodings reliably.

The following example shows how to use the JMS transport in combination with an ActiceMQ connection factory:

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="connectionFactory" class="org.apache.activemq.ActiveMQConnectionFactory">
        <property name="brokerURL" value="vm://localhost?broker.persistent=false"/>
    </bean>

    <bean id="webServiceTemplate"
 class="org.springframework.ws.client.core.WebServiceTemplate">
        <constructor-arg ref="messageFactory"/>
        <property name="messageSender">
            <bean class="org.springframework.ws.transport.jms.JmsMessageSender">
                <property name="connectionFactory" ref="connectionFactory"/>
            </bean>
        </property>
        <property name="defaultUri" value="jms:RequestQueue?deliveryMode=NON_PERSISTENT"/>
    </bean>

</beans>
```

Email transport

Spring Web Services also provides an email transport, which can be used to send web service messages via SMTP, and retrieve them via either POP3 or IMAP. The client-side email functionality is contained in the `MailMessageSender` class. This class creates an email message from the request `WebServiceMessage`, and sends it via SMTP. It then waits for a response message to arrive in the incoming POP3 or IMAP server.

To use the `MailMessageSender`, set the defaultUri or *`uri`* parameter to a `mailto` URI. Here are some URI examples: `mailto:john@example.com`, and `mailto:server@localhost?subject=SOAP%20Test`. Make sure that the message sender is properly configured with a transportUri, which indicates the server to use for sending requests (typically a SMTP server), and a storeUri, which indicates the server to poll for responses (typically a POP3 or IMAP server).

The following example shows how to use the email transport:

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="webServiceTemplate"
 class="org.springframework.ws.client.core.WebServiceTemplate">
        <constructor-arg ref="messageFactory"/>
        <property name="messageSender">
            <bean class="org.springframework.ws.transport.mail.MailMessageSender">
                <property name="from" value="Spring-WS SOAP Client
 &lt;client@example.com&gt;"/>
                <property name="transportUri" value="smtp://client:s04p@smtp.example.com"/
>
                <property name="storeUri" value="imap://client:s04p@imap.example.com/
INBOX"/>
            </bean>
        </property>
        <property name="defaultUri" value="mailto:server@example.com?subject=SOAP%20Test"/
>
    </bean>

</beans>
```

XMPP transport

Spring Web Services 2.0 introduced an XMPP (Jabber) transport, which can be used to send and receive web service messages via XMPP. The client-side XMPP functionality is contained in the `XmppMessageSender` class. This class creates an XMPP message from the request `WebServiceMessage`, and sends it via XMPP. It then listens for a response message to arrive.

To use the `XmppMessageSender`, set the defaultUri or *`uri`* parameter to a `xmpp` URI, for example `xmpp:johndoe@jabber.org`. The sender also requires an `XMPPConnection` to work, which can be conveniently created using the `org.springframework.ws.transport.xmpp.support.XmppConnectionFactoryBean`.

The following example shows how to use the xmpp transport:

```
<beans>

    <bean id="messageFactory"
 class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory"/>

    <bean id="connection"
 class="org.springframework.ws.transport.xmpp.support.XmppConnectionFactoryBean">
        <property name="host" value="jabber.org"/>
        <property name="username" value="username"/>
        <property name="password" value="password"/>
    </bean>

    <bean id="webServiceTemplate"
 class="org.springframework.ws.client.core.WebServiceTemplate">
        <constructor-arg ref="messageFactory"/>
        <property name="messageSender">
            <bean class="org.springframework.ws.transport.xmpp.XmppMessageSender">
                <property name="connection" ref="connection"/>
            </bean>
        </property>
        <property name="defaultUri" value="xmpp:user@jabber.org"/>
    </bean>

</beans>
```

Message factories

In addition to a message sender, the `WebServiceTemplate` requires a Web service message factory. There are two message factories for SOAP: `SaajSoapMessageFactory` and `AxiomSoapMessageFactory`. If no message factory is specified (via the messageFactory property), Spring-WS will use the `SaajSoapMessageFactory` by default.

Sending and receiving a `WebServiceMessage`

The `WebServiceTemplate` contains many convenience methods to send and receive web service messages. There are methods that accept and return a `Source` and those that return a `Result`. Additionally, there are methods which marshal and unmarshal objects to XML. Here is an example that sends a simple XML message to a Web service.

```
import java.io.StringReader;
import javax.xml.transform.stream.StreamResult;
import javax.xml.transform.stream.StreamSource;

import org.springframework.ws.WebServiceMessageFactory;
import org.springframework.ws.client.core.WebServiceTemplate;
import org.springframework.ws.transport.WebServiceMessageSender;

public class WebServiceClient {

    private static final String MESSAGE =
        "<message xmlns=\"http://tempuri.org\">Hello Web Service World</message>";

    private final WebServiceTemplate webServiceTemplate = new WebServiceTemplate();

    public void setDefaultUri(String defaultUri) {
        webServiceTemplate.setDefaultUri(defaultUri);
    }

    // send to the configured default URI
    public void simpleSendAndReceive() {
        StreamSource source = new StreamSource(new StringReader(MESSAGE));
        StreamResult result = new StreamResult(System.out);
        webServiceTemplate.sendSourceAndReceiveToResult(source, result);
    }

    // send to an explicit URI
    public void customSendAndReceive() {
        StreamSource source = new StreamSource(new StringReader(MESSAGE));
        StreamResult result = new StreamResult(System.out);
        webServiceTemplate.sendSourceAndReceiveToResult("http://localhost:8080/
AnotherWebService",
            source, result);
    }

}
```

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

    <bean id="webServiceClient" class="WebServiceClient">
        <property name="defaultUri" value="http://localhost:8080/WebService"/>
    </bean>

</beans>
```

The above example uses the `WebServiceTemplate` to send a hello world message to the web service located at `http://localhost:8080/WebService` (in the case of the `simpleSendAndReceive()` method), and writes the result to the console. The `WebServiceTemplate` is injected with the default URI, which is used because no URI was supplied explicitly in the Java code.

Please note that the `WebServiceTemplate` class is thread-safe once configured (assuming that all of it's dependencies are thread-safe too, which is the case for all of the dependencies that ship with Spring-WS), and so multiple objects can use the same shared `WebServiceTemplate` instance if so desired. The `WebServiceTemplate` exposes a zero argument constructor and messageFactory/messageSender bean properties which can be used for constructing the instance (using a Spring container or plain Java code). Alternatively, consider deriving from Spring-WS's `WebServiceGatewaySupport` convenience base class, which exposes convenient bean properties to

enable easy configuration. (You do *not* have to extend this base class... it is provided as a convenience class only.)

Sending and receiving POJOs - marshalling and unmarshalling

In order to facilitate the sending of plain Java objects, the `WebServiceTemplate` has a number of `send(..)` methods that take an `Object` as an argument for a message's data content. The method `marshalSendAndReceive(..)` in the `WebServiceTemplate` class delegates the conversion of the request object to XML to a `Marshaller`, and the conversion of the response XML to an object to an `Unmarshaller`. (For more information about marshalling and unmarshaller, refer to the Spring documentation.) By using the marshallers, your application code can focus on the business object that is being sent or received and not be concerned with the details of how it is represented as XML. In order to use the marshalling functionality, you have to set a marshaller and unmarshaller with the marshaller/unmarshaller properties of the `WebServiceTemplate` class.

`WebServiceMessageCallback`

To accommodate the setting of SOAP headers and other settings on the message, the `WebServiceMessageCallback` interface gives you access to the message *after* it has been created, but *before* it is sent. The example below demonstrates how to set the SOAP Action header on a message that is created by marshalling an object.

```
public void marshalWithSoapActionHeader(MyObject o) {

    webServiceTemplate.marshalSendAndReceive(o, new WebServiceMessageCallback() {

        public void doWithMessage(WebServiceMessage message) {
            ((SoapMessage)message).setSoapAction("http://tempuri.org/Action");
        }
    });
}
```

Note

Note that you can also use the `org.springframework.ws.soap.client.core.SoapActionCallback` to set the SOAP Action header.

WS-Addressing

In addition to the server-side WS-Addressing support, Spring Web Services also has support for this specification on the client-side.

For setting WS-Addressing headers on the client, you can use the `org.springframework.ws.soap.addressing.client.ActionCallback`. This callback takes the desired Action header as a parameter. It also has constructors for specifying the WS-Addressing version, and a `To` header. If not specified, the `To` header will default to the URL of the connection being made.

Here is an example of setting the `Action` header to `http://samples/RequestOrder`:

```
webServiceTemplate.marshalSendAndReceive(o, new ActionCallback("http://samples/
RequestOrder"));
```

`WebServiceMessageExtractor`

The `WebServiceMessageExtractor` interface is a low-level callback interface that allows you to have full control over the process to extract an `Object` from a received `WebServiceMessage`. The `WebServiceTemplate` will invoke the `extractData(..)` method on a supplied `WebServiceMessageExtractor` *while the underlying connection to the serving resource is still open*. The following example illustrates the `WebServiceMessageExtractor` in action:

```
public void marshalWithSoapActionHeader(final Source s) {
    final Transformer transformer = transformerFactory.newTransformer();
    webServiceTemplate.sendAndReceive(new WebServiceMessageCallback() {
        public void doWithMessage(WebServiceMessage message) {
            transformer.transform(s, message.getPayloadResult());
        },
        new WebServiceMessageExtractor() {
            public Object extractData(WebServiceMessage message) throws IOException
                // do your own transforms with message.getPayloadResult()
                //     or message.getPayloadSource()
            }
        });
}
```

6.3 Client-side testing

When it comes to testing your Web service clients (i.e. classes that uses the `WebServiceTemplate` to access a Web service), there are two possible approaches:

- Write *Unit Tests*, which simply mock away the `WebServiceTemplate` class, `WebServiceOperations` interface, or the complete client class.

  The advantage of this approach is that it's quite easy to accomplish; the disadvantage is that you are not really testing the exact content of the XML messages that are sent over the wire, especially when mocking out the entire client class.

- Write *Integrations Tests*, which do test the contents of the message.

The first approach can easily be accomplished with mocking frameworks such as EasyMock, JMock, etc. The next section will focus on writing integration tests, using the test features introduced in Spring Web Services 2.0.

Writing client-side integration tests

Spring Web Services 2.0 introduced support for creating Web service client integration tests. In this context, a client is a class that uses the `WebServiceTemplate` to access a Web service.

The integration test support lives in the org.springframework.ws.test.client package. The core class in that package is the `MockWebServiceServer`. The underlying idea is that the web service template connects to this mock server, sends it request message, which the mock server then verifies against the registered expectations. If the expectations are met, the mock server then prepares a response message, which is send back to the template.

The typical usage of the `MockWebServiceServer` is:

1. Create a `MockWebServiceServer` instance by calling `MockWebServiceServer.createServer(WebServiceTemplate)`,

`MockWebServiceServer.createServer(WebServiceGatewaySupport)`, or `MockWebServiceServer.createServer(ApplicationContext)`.

2. Set up request expectations by calling `expect(RequestMatcher)`, possibly by using the default `RequestMatcher` implementations provided in `RequestMatchers` (which can be statically imported). Multiple expectations can be set up by chaining `andExpect(RequestMatcher)` calls.
3. Create an appropriate response message by calling `andRespond(ResponseCreator)`, possibly by using the default `ResponseCreator` implementations provided in `ResponseCreators` (which can be statically imported).
4. Use the `WebServiceTemplate` as normal, either directly of through client code.
5. Call `MockWebServiceServer.verify()` to make sure that all expectations have been met.

Note

Note that the `MockWebServiceServer` (and related classes) offers a 'fluent' API, so you can typically use the Code Completion features (i.e. ctrl-space) in your IDE to guide you through the process of setting up the mock server.

Note

Also note that you rely on the standard logging features available in Spring Web Services in your unit tests. Sometimes it might be useful to inspect the request or response message to find out why a particular tests failed. See Section 4.4, “Message Logging and Tracing” for more information.

Consider, for example, this Web service client class:

```
import org.springframework.ws.client.core.support.WebServiceGatewaySupport;

public class CustomerClient extends WebServiceGatewaySupport {                    ❶

  public int getCustomerCount() {
    CustomerCountRequest request = new CustomerCountRequest();                     ❷
    request.setCustomerName("John Doe");

    CustomerCountResponse response =
      (CustomerCountResponse) getWebServiceTemplate().marshalSendAndReceive(request);    ❸

    return response.getCustomerCount();
  }

}
```

❶ The `CustomerClient` extends `WebServiceGatewaySupport`, which provides it with a webServiceTemplate property.

❷ `CustomerCountRequest` is an object supported by a marshaller. For instance, it can have a `@XmlRootElement` annotation to be supported by JAXB2.

❸ The `CustomerClient` uses the `WebServiceTemplate` offered by `WebServiceGatewaySupport` to marshal the request object into a SOAP message, and sends that to the web service. The response object is unmarshalled into a `CustomerCountResponse`.

A typical test for `CustomerClient` would look like this:

```
import javax.xml.transform.Source;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.test.context.ContextConfiguration;
import org.springframework.test.context.junit4.SpringJUnit4ClassRunner;
import org.springframework.xml.transform.StringSource;

import org.junit.Before;
import org.junit.Test;
import org.junit.runner.RunWith;

import static org.junit.Assert.assertEquals;

import org.springframework.ws.test.client.MockWebServiceServer;                          ❶
import static org.springframework.ws.test.client.RequestMatchers.*;                      ❶
import static org.springframework.ws.test.client.ResponseCreators.*;                     ❶

@RunWith(SpringJUnit4ClassRunner.class)                                                  ❷
@ContextConfiguration("integration-test.xml")                                            ❷
public class CustomerClientIntegrationTest {

  @Autowired
  private CustomerClient client;                                                         ❸

  private MockWebServiceServer mockServer;                                               ❹

  @Before
  public void createServer() throws Exception {
    mockServer = MockWebServiceServer.createServer(client);
  }

  @Test
  public void customerClient() throws Exception {
    Source requestPayload = new StringSource(
      "<customerCountRequest xmlns='http://springframework.org/spring-ws'>" +
        "<customerName>John Doe</customerName>" +
      "</customerCountRequest>");
    Source responsePayload = new StringSource(
      "<customerCountResponse xmlns='http://springframework.org/spring-ws'>" +
        "<customerCount>10</customerCount>" +
      "</customerCountResponse>");

    mockServer.expect(payload(requestPayload)).andRespond(withPayload(responsePayload)); ❺

    int result = client.getCustomerCount();                                              ❻
    assertEquals(10, result);                                                            ❻

    mockServer.verify();                                                                 ❼
  }

}
```

❶ The `CustomerClientIntegrationTest` imports the `MockWebServiceServer`, and statically imports `RequestMatchers` and `ResponseCreators`.

❷ This test uses the standard testing facilities provided in the Spring Framework. This is not required, but is generally the easiest way to set up the test.

❸ The `CustomerClient` is configured in `integration-test.xml`, and wired into this test using `@Autowired`.

❹ In a `@Before` method, we create a `MockWebServiceServer` by using the `createServer` factory method.

❺ We define expectations by calling `expect()` with a `payload()` `RequestMatcher` provided by the statically imported `RequestMatchers` (see the section called “`RequestMatcher` and `RequestMatchers`”).

We also set up a response by calling `andRespond()` with a `withPayload()` `ResponseCreator` provided by the statically imported `ResponseCreators` (see the section called “`ResponseCreator` and `ResponseCreators`”).

This part of the test might look a bit confusing, but the Code Completion features of your IDE are of great help. After typing `expect(`, simply type ctrl-space, and your IDE will provide you with a list of possible request matching strategies, provided you statically imported `RequestMatchers`. The same applies to `andRespond(`, provided you statically imported `ResponseCreators`.

❻ We call `getCustomerCount()` on the `CustomerClient`, thus using the `WebServiceTemplate`. The template has been set up for 'testing mode' by now, so no real (HTTP) connection is made by this method call. We also make some JUnit assertions based on the result of the method call.

❼ We call `verify()` on the `MockWebServiceServer`, thus verifying that the expected message was actually received.

`RequestMatcher` and `RequestMatchers`

To verify whether the request message meets certain expectations, the `MockWebServiceServer` uses the `RequestMatcher` strategy interface. The contract defined by this interface is quite simple:

```
public interface RequestMatcher {

  void match(URI uri,
             WebServiceMessage request)
    throws IOException,
           AssertionError;

}
```

You can write your own implementations of this interface, throwing `AssertionErrors` when the message does not meet your expectations, but you certainly do not have to. The `RequestMatchers` class provides standard `RequestMatcher` implementations for you to use in your tests. You will typically statically import this class.

The `RequestMatchers` class provides the following request matchers:

`RequestMatchers` method	Description
`anything()`	Expects any sort of request.
`payload()`	Expects a given request payload.
`validPayload()`	Expects the request payload to validate against given XSD schema(s).
`xpath()`	Expects a given XPath expression to exist, not exist, or evaluate to a given value.

RequestMatchers method	Description
soapHeader()	Expects a given SOAP header to exist in the request message.
connectionTo()	Expects a connection to the given URL.

You can set up multiple request expectations by chaining andExpect() calls, like so:

```
mockServer.expect(connectionTo("http://example.com")).
 andExpect(payload(expectedRequestPayload)).
 andExpect(validPayload(schemaResource)).
 andRespond(...);
```

For more information on the request matchers provided by RequestMatchers, refer to the class level Javadoc.

ResponseCreator and ResponseCreators

When the request message has been verified and meets the defined expectations, the MockWebServiceServer will create a response message for the WebServiceTemplate to consume. The server uses the ResponseCreator strategy interface for this purpose:

```
public interface ResponseCreator {

  WebServiceMessage createResponse(URI uri,
                                   WebServiceMessage request,
                                   WebServiceMessageFactory messageFactory)
    throws IOException;

}
```

Once again you can write your own implementations of this interface, creating a response message by using the message factory, but you certainly do not have to, as the ResponseCreators class provides standard ResponseCreator implementations for you to use in your tests. You will typically statically import this class.

The ResponseCreators class provides the following responses:

ResponseCreators method	Description
withPayload()	Creates a response message with a given payload.
withError()	Creates an error in the response connection. This method gives you the opportunity to test your error handling.
withException()	Throws an exception when reading from the response connection. This method gives you the opportunity to test your exception handling.
withMustUnderstandFault(), withClientOrSenderFault(),	Creates a response message with a given SOAP fault. This method gives you the opportunity to test your Fault handling.

`ResponseCreators` method	Description
`withServerOrReceiverFault()`, and `withVersionMismatchFault()`	

For more information on the request matchers provided by `RequestMatchers`, refer to the class level Javadoc.

7. Securing your Web services with Spring-WS

7.1 Introduction

This chapter explains how to add WS-Security aspects to your Web services. We will focus on the three different areas of WS-Security, namely:

Authentication. This is the process of determining whether a *principal* is who they claim to be. In this context, a "principal" generally means a user, device or some other system which can perform an action in your application.

Digital signatures. The digital signature of a message is a piece of information based on both the document and the signer's private key. It is created through the use of a hash function and a private signing function (encrypting with the signer's private key).

Encryption and Decryption. *Encryption* is the process of transforming data into a form that is impossible to read without the appropriate key. It is mainly used to keep information hidden from anyone for whom it is not intended. *Decryption* is the reverse of encryption; it is the process of transforming of encrypted data back into an readable form.

All of these three areas are implemented using the `XwsSecurityInterceptor` or `Wss4jSecurityInterceptor`, which we will describe in Section 7.2, “ `XwsSecurityInterceptor` ” and Section 7.3, “ `Wss4jSecurityInterceptor` ”, respectively

Note

Note that WS-Security (especially encryption and signing) requires substantial amounts of memory, and will also decrease performance. If performance is important to you, you might want to consider not using WS-Security, or simply use HTTP-based security.

7.2 `XwsSecurityInterceptor`

The `XwsSecurityInterceptor` is an `EndpointInterceptor` (see the section called “Intercepting requests - the `EndpointInterceptor` interface”) that is based on SUN's XML and Web Services Security package (XWSS). This WS-Security implementation is part of the Java Web Services Developer Pack (*Java WSDP*).

Like any other endpoint interceptor, it is defined in the endpoint mapping (see Section 5.5, “Endpoint mappings”). This means that you can be selective about adding WS-Security support: some endpoint mappings require it, while others do not.

Note

Note that XWSS requires both a SUN 1.5 JDK and the SUN SAAJ reference implementation. The WSS4J interceptor does not have these requirements (see Section 7.3, “ `Wss4jSecurityInterceptor` ”).

The `XwsSecurityInterceptor` requires a *security policy file* to operate. This XML file tells the interceptor what security aspects to require from incoming SOAP messages, and what aspects to add to outgoing messages. The basic format of the policy file will be explained in the following sections, but you can find a more in-depth tutorial *here* . You can set the policy with the policyConfiguration property, which requires a Spring resource. The policy file can contain multiple elements, e.g.

require a username token on incoming messages, and sign all outgoing messages. It contains a `SecurityConfiguration` element as root (not a `JAXRPCSecurity` element).

Additionally, the security interceptor requires one or more`CallbackHandlers` to operate. These handlers are used to retrieve certificates, private keys, validate user credentials, etc. Spring-WS offers handlers for most common security concerns, e.g. authenticating against a Spring Security authentication manager, signing outgoing messages based on a X509 certificate. The following sections will indicate what callback handler to use for which security concern. You can set the callback handlers using the callbackHandler or callbackHandlers property.

Here is an example that shows how to wire the `XwsSecurityInterceptor` up:

```
<beans>
    <bean id="wsSecurityInterceptor"
        class="org.springframework.ws.soap.security.xwss.XwsSecurityInterceptor">
        <property name="policyConfiguration" value="classpath:securityPolicy.xml"/>
        <property name="callbackHandlers">
            <list>
                <ref bean="certificateHandler"/>
                <ref bean="authenticationHandler"/>
            </list>
        </property>
    </bean>
    ...
</beans>
```

This interceptor is configured using the `securityPolicy.xml` file on the classpath. It uses two callback handlers which are defined further on in the file.

Keystores

For most cryptographic operations, you will use the standard `java.security.KeyStore` objects. These operations include certificate verification, message signing, signature verification, and encryption, but excludes username and time-stamp verification. This section aims to give you some background knowledge on keystores, and the Java tools that you can use to store keys and certificates in a keystore file. This information is mostly not related to Spring-WS, but to the general cryptographic features of Java.

The `java.security.KeyStore` class represents a storage facility for cryptographic keys and certificates. It can contain three different sort of elements:

Private Keys. These keys are used for self-authentication. The private key is accompanied by certificate chain for the corresponding public key. Within the field of WS-Security, this accounts to message signing and message decryption.

Symmetric Keys. Symmetric (or secret) keys are used for message encryption and decryption as well. The difference being that both sides (sender and recipient) share the same, secret key.

Trusted certificates. These X509 certificates are called a *trusted certificate* because the keystore owner trusts that the public key in the certificates indeed belong to the owner of the certificate. Within WS-Security, these certificates are used for certificate validation, signature verification, and encryption.

KeyTool

Supplied with your Java Virtual Machine is the **keytool** program, a key and certificate management utility. You can use this tool to create new keystores, add new private keys and certificates to them, etc.

It is beyond the scope of this document to provide a full reference of the **keytool** command, but you can find a reference *here* , or by giving the command `keytool -help` on the command line.

KeyStoreFactoryBean

To easily load a keystore using Spring configuration, you can use the `KeyStoreFactoryBean`. It has a resource location property, which you can set to point to the path of the keystore to load. A password may be given to check the integrity of the keystore data. If a password is not given, integrity checking is not performed.

```
<bean id="keyStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
    <property name="password" value="password"/>
    <property name="location" value="classpath:org/springframework/ws/soap/security/xwss/
test-keystore.jks"/>
</bean>
```

Caution

If you don't specify the location property, a new, empty keystore will be created, which is most likely not what you want.

KeyStoreCallbackHandler

To use the keystores within a `XwsSecurityInterceptor`, you will need to define a `KeyStoreCallbackHandler`. This callback has three properties with type keystore: (`keyStore`,`trustStore`, and `symmetricStore`). The exact stores used by the handler depend on the cryptographic operations that are to be performed by this handler. For private key operation, the `keyStore` is used, for symmetric key operations the `symmetricStore`, and for determining trust relationships, the `trustStore`. The following table indicates this:

Cryptographic operation	Keystore used
Certificate validation	first the`keyStore`, then the `trustStore`
Decryption based on private key	`keyStore`
Decryption based on symmetric key	`symmetricStore`
Encryption based on public key certificate	`trustStore`
Encryption based on symmetric key	`symmetricStore`
Signing	`keyStore`
Signature verification	`trustStore`

Additionally, the `KeyStoreCallbackHandler` has a `privateKeyPassword` property, which should be set to unlock the private key(s) contained in the`keyStore`.

If the `symmetricStore` is not set, it will default to the `keyStore`. If the key or trust store is not set, the callback handler will use the standard Java mechanism to load or create it. Refer to the JavaDoc of the `KeyStoreCallbackHandler` to know how this mechanism works.

For instance, if you want to use the `KeyStoreCallbackHandler` to validate incoming certificates or signatures, you would use a trust store, like so:

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="trustStore" ref="trustStore"/>
    </bean>

    <bean id="trustStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:truststore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

If you want to use it to decrypt incoming certificates or sign outgoing messages, you would use a key store, like so:

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="keyStore" ref="keyStore"/>
        <property name="privateKeyPassword" value="changeit"/>
    </bean>

    <bean id="keyStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:keystore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

The following sections will indicate where the `KeyStoreCallbackHandler` can be used, and which properties to set for particular cryptographic operations.

Authentication

As stated in the introduction, *authentication* is the task of determining whether a principal is who they claim to be. Within WS-Security, authentication can take two forms: using a username and password token (using either a plain text password or a password digest), or using a X509 certificate.

Plain Text Username Authentication

The simplest form of username authentication uses*plain text passwords*. In this scenario, the SOAP message will contain a `UsernameToken` element, which itself contains a `Username` element and a `Password` element which contains the plain text password. Plain text authentication can be compared to the Basic Authentication provided by HTTP servers.

Warning

Note that plain text passwords are not very secure. Therefore, you should always add additional security measures to your transport layer if you are using them (using HTTPS instead of plain HTTP, for instance).

To require that every incoming message contains a `UsernameToken` with a plain text password, the security policy file should contain a `RequireUsernameToken` element, with the `passwordDigestRequired` attribute set to`false`. You can find a reference of possible child elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
    ...
    <xwss:RequireUsernameToken passwordDigestRequired="false" nonceRequired="false"/>
    ...
</xwss:SecurityConfiguration>
```

If the username token is not present, the `XwsSecurityInterceptor` will return a SOAP Fault to the sender. If it is present, it will fire a `PasswordValidationCallback` with a `PlainTextPasswordRequest` to the registered handlers. Within Spring-WS, there are three classes which handle this particular callback.

SimplePasswordValidationCallbackHandler

The simplest password validation handler is the `SimplePasswordValidationCallbackHandler`. This handler validates passwords against an in-memory `Properties` object, which you can specify using the `users` property, like so:

```
<bean id="passwordValidationHandler"

 class="org.springframework.ws.soap.security.xwss.callback.SimplePasswordValidationCallbackHandler">
    <property name="users">
        <props>
            <prop key="Bert">Ernie</prop>
        </props>
    </property>
</bean>
```

In this case, we are only allowing the user "Bert" to log in using the password "Ernie".

SpringPlainTextPasswordValidationCallbackHandler

The `SpringPlainTextPasswordValidationCallbackHandler` uses *Spring Security* to authenticate users. It is beyond the scope of this document to describe Spring Security, but suffice it to say that it is a full-fledged security framework. You can read more about it in the *Spring Security reference documentation* .

The `SpringPlainTextPasswordValidationCallbackHandler` requires an `AuthenticationManager` to operate. It uses this manager to authenticate against a `UsernamePasswordAuthenticationToken` that it creates. If authentication is successful, the token is stored in the `SecurityContextHolder`. You can set the authentication manager using the `authenticationManager`property:

```
<beans>
  <bean id="springSecurityHandler"

 class="org.springframework.ws.soap.security.xwss.callback.SpringPlainTextPasswordValidationCallbackHandler"
    <property name="authenticationManager" ref="authenticationManager"/>
  </bean>

  <bean id="authenticationManager"
 class="org.springframework.security.providers.ProviderManager">
      <property name="providers">
          <bean
 class="org.springframework.security.providers.dao.DaoAuthenticationProvider">
              <property name="userDetailsService" ref="userDetailsService"/>
          </bean>
      </property>
  </bean>

  <bean id="userDetailsService" class="com.mycompany.app.dao.UserDetailService" />
  ...
</beans>
```

JaasPlainTextPasswordValidationCallbackHandler

The `JaasPlainTextPasswordValidationCallbackHandler` is based on the standard *Java Authentication and Authorization Service* . It is beyond the scope of this document to provide a full introduction into JAAS, but there is a *good tutorial* available.

The `JaasPlainTextPasswordValidationCallbackHandler` requires only a `loginContextName` to operate. It creates a new JAAS `LoginContext` using this name, and handles the standard JAAS `NameCallback` and `PasswordCallback` using the username and password provided in the SOAP message. This means that this callback handler integrates with any JAAS `LoginModule` that fires these callbacks during the `login()` phase, which is standard behavior.

You can wire up a `JaasPlainTextPasswordValidationCallbackHandler` as follows:

```
<bean id="jaasValidationHandler"

 class="org.springframework.ws.soap.security.xwss.callback.jaas.JaasPlainTextPasswordValidationCallbackHandl
    <property name="loginContextName" value="MyLoginModule" />
</bean>
```

In this case, the callback handler uses the `LoginContext` named "MyLoginModule". This module should be defined in your `jaas.config` file, as explained in the abovementioned tutorial.

Digest Username Authentication

When using password digests, the SOAP message also contains a `UsernameToken` element, which itself contains a `Username` element and a `Password` element. The difference is that the password is not sent as plain text, but as a *digest*. The recipient compares this digest to the digest he calculated from the known password of the user, and if they are the same, the user is authenticated. It can be compared to the Digest Authentication provided by HTTP servers.

To require that every incoming message contains a `UsernameToken` element with a password digest, the security policy file should contain a `RequireUsernameToken` element, with the `passwordDigestRequired` attribute set to`true`. Additionally, the `nonceRequired` should be set to`true`: You can find a reference of possible child elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
    ...
    <xwss:RequireUsernameToken passwordDigestRequired="true" nonceRequired="true"/>
    ...
</xwss:SecurityConfiguration>
```

If the username token is not present, the `XwsSecurityInterceptor` will return a SOAP Fault to the sender. If it is present, it will fire a `PasswordValidationCallback` with a `DigestPasswordRequest` to the registered handlers. Within Spring-WS, there are two classes which handle this particular callback.

SimplePasswordValidationCallbackHandler

The `SimplePasswordValidationCallbackHandler` can handle both plain text passwords as well as password digests. It is described inthe section called “SimplePasswordValidationCallbackHandler”.

SpringDigestPasswordValidationCallbackHandler

The `SpringDigestPasswordValidationCallbackHandler` requires an Spring Security `UserDetailService` to operate. It uses this service to retrieve the password of the user specified in the token. The digest of the password contained in this details object is then compared with the digest in the message. If they are equal, the user has successfully authenticated, and a `UsernamePasswordAuthenticationToken` is stored in the `SecurityContextHolder`. You can set the service using the `userDetailsService`. Additionally, you can set a `userCache` property, to cache loaded user details.

```
<beans>
    <bean
 class="org.springframework.ws.soap.security.xwss.callback.SpringDigestPasswordValidationCallbackHandler">
        <property name="userDetailsService" ref="userDetailsService"/>
    </bean>

    <bean id="userDetailsService" class="com.mycompany.app.dao.UserDetailService" />
    ...
</beans>
```

Certificate Authentication

A more secure way of authentication uses X509 certificates. In this scenerario, the SOAP message contains a`BinarySecurityToken`, which contains a Base 64-encoded version of a X509 certificate. The certificate is used by the recipient to authenticate. The certificate stored in the message is also used to sign the message (seethe section called “Verifying Signatures”).

To make sure that all incoming SOAP messages carry a`BinarySecurityToken`, the security policy file should contain a `RequireSignature` element. This element can further carry other elements, which will be covered inthe section called “Verifying Signatures”. You can find a reference of possible child elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
    ...
    <xwss:RequireSignature requireTimestamp="false">
    ...
</xwss:SecurityConfiguration>
```

When a message arrives that carries no certificate, the `XwsSecurityInterceptor` will return a SOAP Fault to the sender. If it is present, it will fire a `CertificateValidationCallback`. There are three handlers within Spring-WS which handle this callback for authentication purposes.

Note

In most cases, certificate *authentication* should be preceded by certificate *validation*, since you only want to authenticate against valid certificates. Invalid certificates such as certificates for which the expiration date has passed, or which are not in your store of trusted certificates, should be ignored.

In Spring-WS terms, this means that the `SpringCertificateValidationCallbackHandler` or `JaasCertificateValidationCallbackHandler` should be preceded by `KeyStoreCallbackHandler`. This can be accomplished by setting the order of the `callbackHandlers` property in the configuration of the `XwsSecurityInterceptor`:

```
<bean id="wsSecurityInterceptor"
    class="org.springframework.ws.soap.security.xwss.XwsSecurityInterceptor">
    <property name="policyConfiguration" value="classpath:securityPolicy.xml"/>
    <property name="callbackHandlers">
        <list>
            <ref bean="keyStoreHandler"/>
            <ref bean="springSecurityHandler"/>
        </list>
    </property>
</bean>
```

Using this setup, the interceptor will first determine if the certificate in the message is valid using the keystore, and then authenticate against it.

KeyStoreCallbackHandler

The `KeyStoreCallbackHandler` uses a standard Java keystore to validate certificates. This certificate validation process consists of the following steps:

1. First, the handler will check whether the certificate is in the private `keyStore`. If it is, it is valid.
2. If the certificate is not in the private keystore, the handler will check whether the current date and time are within the validity period given in the certificate. If they are not, the certificate is invalid; if it is, it will continue with the final step.
3. Finally, a *certification path* for the certificate is created. This basically means that the handler will determine whether the certificate has been issued by any of the certificate authorities in the`trustStore`. If a certification path can be built successfully, the certificate is valid. Otherwise, the certificate is not.

To use the `KeyStoreCallbackHandler` for certificate validation purposes, you will most likely set only the `trustStore` property:

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="trustStore" ref="trustStore"/>
    </bean>

    <bean id="trustStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:truststore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

Using this setup, the certificate that is to be validated must either be in the trust store itself, or the trust store must contain a certificate authority that issued the certificate.

SpringCertificateValidationCallbackHandler

The `SpringCertificateValidationCallbackHandler` requires an Spring Security `AuthenticationManager` to operate. It uses this manager to authenticate against a `X509AuthenticationToken` that it creates. The configured authentication manager is expected to supply a provider which can handle this token (usually an instance of `X509AuthenticationProvider`). If authentication is succesful, the token is stored in the `SecurityContextHolder`. You can set the authentication manager using the authenticationManager property:

```
<beans>
    <bean id="springSecurityCertificateHandler"

 class="org.springframework.ws.soap.security.xwss.callback.SpringCertificateValidationCallbackHandler">
        <property name="authenticationManager" ref="authenticationManager"/>
    </bean>

    <bean id="authenticationManager"
        class="org.springframework.security.providers.ProviderManager">
        <property name="providers">
            <bean
 class="org.springframework.ws.soap.security.x509.X509AuthenticationProvider">
                <property name="x509AuthoritiesPopulator">
                    <bean
 class="org.springframework.ws.soap.security.x509.populator.DaoX509AuthoritiesPopulator">
                        <property name="userDetailsService" ref="userDetailsService"/>
                    </bean>
                </property>
            </bean>
        </property>
    </bean>

  <bean id="userDetailsService" class="com.mycompany.app.dao.UserDetailService" />
  ...
</beans>
```

In this case, we are using a custom user details service to obtain authentication details based on the certificate. Refer to the *Spring Security reference documentation* for more information about authentication against X509 certificates.

JaasCertificateValidationCallbackHandler

The `JaasCertificateValidationCallbackHandler` requires a `loginContextName` to operate. It creates a new JAAS `LoginContext` using this name and with the `X500Principal` of the certificate. This means that this callback handler integrates with any JAAS `LoginModule` that handles X500 principals.

You can wire up a `JaasCertificateValidationCallbackHandler` as follows:

```
<bean id="jaasValidationHandler"

 class="org.springframework.ws.soap.security.xwss.callback.jaas.JaasCertificateValidationCallbackHandler">
    <property name="loginContextName">MyLoginModule</property>
</bean>
```

In this case, the callback handler uses the `LoginContext` named "MyLoginModule". This module should be defined in your `jaas.config` file, and should be able to authenticate against X500 principals.

Digital Signatures

The *digital signature* of a message is a piece of information based on both the document and the signer's private key. There are two main tasks related to signatures in WS-Security: verifying signatures and signing messages.

Verifying Signatures

Just likecertificate-based authentication, a signed message contains a `BinarySecurityToken`, which contains the certificate used to sign the message. Additionally, it contains a `SignedInfo` block, which indicates what part of the message was signed.

To make sure that all incoming SOAP messages carry a`BinarySecurityToken`, the security policy file should contain a `RequireSignature` element. It can also contain a `SignatureTarget` element, which specifies the target message part which was expected to be signed, and various other subelements. You can also define the private key alias to use, whether to use a symmetric instead of a private key, and many other properties. You can find a reference of possible child elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
    <xwss:RequireSignature requireTimestamp="false"/>
</xwss:SecurityConfiguration>
```

If the signature is not present, the `XwsSecurityInterceptor` will return a SOAP Fault to the sender. If it is present, it will fire a `SignatureVerificationKeyCallback` to the registered handlers. Within Spring-WS, there are is one class which handles this particular callback: the `KeyStoreCallbackHandler`.

KeyStoreCallbackHandler

As described inthe section called “KeyStoreCallbackHandler”, the `KeyStoreCallbackHandler` uses a `java.security.KeyStore` for handling various cryptographic callbacks, including signature verification. For signature verification, the handler uses the `trustStore` property:

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="trustStore" ref="trustStore"/>
    </bean>

    <bean id="trustStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:org/springframework/ws/soap/security/
xwss/test-truststore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

Signing Messages

When signing a message, the `XwsSecurityInterceptor` adds the `BinarySecurityToken` to the message, and a `SignedInfo` block, which indicates what part of the message was signed.

To sign all outgoing SOAP messages, the security policy file should contain a `Sign` element. It can also contain a `SignatureTarget` element, which specifies the target message part which was expected to be signed, and various other subelements. You can also define the private key alias to use, whether to use a symmetric instead of a private key, and many other properties. You can find a reference of possible child elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
 <xwss:Sign includeTimestamp="false" />
</xwss:SecurityConfiguration>
```

The `XwsSecurityInterceptor` will fire a `SignatureKeyCallback` to the registered handlers. Within Spring-WS, there are is one class which handles this particular callback: the `KeyStoreCallbackHandler`.

KeyStoreCallbackHandler

As described inthe section called “KeyStoreCallbackHandler”, the `KeyStoreCallbackHandler` uses a `java.security.KeyStore` for handling various cryptographic callbacks, including signing messages. For adding signatures, the handler uses the `keyStore` property. Additionally, you must set the `privateKeyPassword` property to unlock the private key used for signing.

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="keyStore" ref="keyStore"/>
        <property name="privateKeyPassword" value="changeit"/>
    </bean>

    <bean id="keyStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:keystore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

Encryption and Decryption

When *encrypting*, the message is transformed into a form that can only be read with the appropriate key. The message can be *decrypted* to reveal the original, readable message.

Decryption

To decrypt incoming SOAP messages, the security policy file should contain a `RequireEncryption` element. This element can further carry a `EncryptionTarget` element which indicates which part of the message should be encrypted, and a `SymmetricKey` to indicate that a shared secret instead of the regular private key should be used to decrypt the message. You can read a description of the other elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
    <xwss:RequireEncryption />
</xwss:SecurityConfiguration>
```

If an incoming message is not encrypted, the `XwsSecurityInterceptor` will return a SOAP Fault to the sender. If it is present, it will fire a `DecryptionKeyCallback` to the registered handlers. Within Spring-WS, there is one class which handled this particular callback: the`KeyStoreCallbackHandler`.

KeyStoreCallbackHandler

As described inthe section called “KeyStoreCallbackHandler”, the `KeyStoreCallbackHandler` uses a `java.security.KeyStore` for handling various cryptographic callbacks, including decryption. For decryption, the handler uses the `keyStore` property. Additionally, you must set the `privateKeyPassword` property to unlock the private key used for decryption. For decryption based on symmetric keys, it will use the `symmetricStore`.

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="keyStore" ref="keyStore"/>
        <property name="privateKeyPassword" value="changeit"/>
    </bean>

    <bean id="keyStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:keystore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

Encryption

To encrypt outgoing SOAP messages, the security policy file should contain a `Encrypt` element. This element can further carry a `EncryptionTarget` element which indicates which part of the message should be encrypted, and a `SymmetricKey` to indicate that a shared secret instead of the regular public key should be used to encrypt the message. You can read a description of the other elements *here* .

```
<xwss:SecurityConfiguration xmlns:xwss="http://java.sun.com/xml/ns/xwss/config">
    <xwss:Encrypt />
</xwss:SecurityConfiguration>
```

The `XwsSecurityInterceptor` will fire a `EncryptionKeyCallback` to the registered handlers in order to retrieve the encryption information. Within Spring-WS, there is one class which handled this particular callback: the `KeyStoreCallbackHandler`.

KeyStoreCallbackHandler

As described inthe section called “KeyStoreCallbackHandler”, the `KeyStoreCallbackHandler` uses a `java.security.KeyStore` for handling various cryptographic callbacks, including encryption. For encryption based on public keys, the handler uses the `trustStore` property. For encryption based on symmetric keys, it will use the`symmetricStore`.

```
<beans>
    <bean id="keyStoreHandler"
 class="org.springframework.ws.soap.security.xwss.callback.KeyStoreCallbackHandler">
        <property name="trustStore" ref="trustStore"/>
    </bean>

    <bean id="trustStore"
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
        <property name="location" value="classpath:truststore.jks"/>
        <property name="password" value="changeit"/>
    </bean>
</beans>
```

Security Exception Handling

When an securement or validation action fails, the `XwsSecurityInterceptor` will throw a `WsSecuritySecurementException` or `WsSecurityValidationException` respectively. These exceptions bypass the standard exception handling mechanism, but are handled in the interceptor itself.

`WsSecuritySecurementException` exceptions are handled in the `handleSecurementException` method of the `XwsSecurityInterceptor`. By default, this method will simply log an error, and stop further processing of the message.

Similarly, `WsSecurityValidationException` exceptions are handled in the `handleValidationException` method of the `XwsSecurityInterceptor`. By default, this method will create a SOAP 1.1 Client or SOAP 1.2 Sender Fault, and send that back as a response.

Note

Both `handleSecurementException` and `handleValidationException` are protected methods, which you can override to change their default behavior.

7.3 `Wss4jSecurityInterceptor`

The `Wss4jSecurityInterceptor` is an `EndpointInterceptor` (see the section called “Intercepting requests - the `EndpointInterceptor` interface”) that is based on Apache's WSS4J.

WSS4J implements the following standards:

- OASIS Web Serives Security: SOAP Message Security 1.0 Standard 200401, March 2004
- Username Token profile V1.0
- X.509 Token Profile V1.0

This interceptor supports messages created by the `AxiomSoapMessageFactory` and the `SaajSoapMessageFactory`.

Configuring `Wss4jSecurityInterceptor`

WSS4J uses no external configuration file; the interceptor is entirely configured by properties. The validation and securement actions executed by this interceptor are specified via validationActions and securementActions properties, respectively. Actions are passed as a space-separated strings. Here is an example configuration:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="UsernameToken Encrypt"/>
    ...
    <property name="securementActions" value="Encrypt"/>
    ...
</bean>
```

Validation actions are:

Validation action	Description
`UsernameToken`	Validates username token
`Timestamp`	Validates the timestamp
`Encrypt`	Decrypts the message
`Signature`	Validates the signature
`NoSecurity`	No action performed

Securement actions are:

Securement action	Description
`UsernameToken`	Adds a username token
`UsernameTokenSignature`	Adds a username token and a signature username token secret key
`Timestamp`	Adds a timestamp
`Encrypt`	Encrypts the response
`Signature`	Signs the response
`NoSecurity`	No action performed

The order of the actions is significant and is enforced by the interceptor. The interceptor will reject an incoming SOAP message if its security actions were performed in a different order than the one specified by`validationActions`.

Handling Digital Certificates

For cryptographic operations requiring interaction with a keystore or certificate handling (signature, encryption and decryption operations), WSS4J requires an instance of`org.apache.ws.security.components.crypto.Crypto`.

`Crypto` instances can be obtained from WSS4J's `CryptoFactory` or more conveniently with the Spring-WS`CryptoFactoryBean`.

CryptoFactoryBean

Spring-WS provides a convenient factory bean, `CryptoFactoryBean` that constructs and configures `Crypto` instances via strong-typed properties (prefered) or through a `Properties` object.

By default, `CryptoFactoryBean` returns instances of `org.apache.ws.security.components.crypto.Merlin`. This can be changed by setting the cryptoProvider property (or its equivalent `org.apache.ws.security.crypto.provider` string property).

Here is a simple example configuration:

```
<bean class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
    <property name="keyStorePassword" value="mypassword"/>
    <property name="keyStoreLocation" value="file:/path_to_keystore/keystore.jks"/>
</bean>
```

Authentication

Validating Username Token

Spring-WS provides a set of callback handlers to integrate with Spring Security. Additionally, a simple callback handler `SimplePasswordValidationCallbackHandler` is provided to configure users and passwords with an in-memory `Properties` object.

Callback handlers are configured via `Wss4jSecurityInterceptor`'s validationCallbackHandler property.

SimplePasswordValidationCallbackHandler

`SimplePasswordValidationCallbackHandler` validates plain text and digest username tokens against an in-memory `Properties` object. It is configured as follows:

```
<bean id="callbackHandler"

 class="org.springframework.ws.soap.security.wss4j.callback.SimplePasswordValidationCallbackHandler">
    <property name="users">
        <props>
            <prop key="Bert">Ernie</prop>
        </props>
    </property>
</bean>
```

SpringSecurityPasswordValidationCallbackHandler

The `SpringSecurityPasswordValidationCallbackHandler` validates plain text and digest passwords using a Spring Security `UserDetailService` to operate. It uses this service to retrieve the (digest of) the password of the user specified in the token. The (digest of) the password contained in this details object is then compared with the digest in the message. If they are equal, the user has successfully authenticated, and a `UsernamePasswordAuthenticationToken` is stored in

the`SecurityContextHolder`. You can set the service using the userDetailsService. Additionally, you can set a userCache property, to cache loaded user details.

```
<beans>
    <bean
 class="org.springframework.ws.soap.security.wss4j.callback.SpringDigestPasswordValidationCallbackHandler">
        <property name="userDetailsService" ref="userDetailsService"/>
    </bean>

    <bean id="userDetailsService" class="com.mycompany.app.dao.UserDetailService" />
    ...
</beans>
```

Adding Username Token

Adding a username token to an outgoing message is as simple as adding `UsernameToken` to the securementActions property of the `Wss4jSecurityInterceptor` and specifying securementUsername andsecurementPassword.

The password type can be set via the securementPasswordType property. Possible values are `PasswordText` for plain text passwords or `PasswordDigest` for digest passwords, which is the default.

The following example generates a username token with a digest password:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="UsernameToken"/>
    <property name="securementUsername" value="Ernie"/>
    <property name="securementPassword" value="Bert"/>
</bean>
```

If plain text password type is chosen, it is possible to instruct the interceptor to add `Nonce` and/or `Created` elements using the securementUsernameTokenElements property. The value must be a list containing the desired elements' names separated by spaces (case sensitive).

The next example generates a username token with a plain text password, a `Nonce` and a `Created` element:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="UsernameToken"/>
    <property name="securementUsername" value="Ernie"/>
    <property name="securementPassword" value="Bert"/>
    <property name="securementPasswordType" value="PasswordText"/>
    <property name="securementUsernameTokenElements" value="Nonce Created"/>
</bean>
```

Certificate Authentication

As certificate authentication is akin to digital signatures, WSS4J handles it as part of the signature validation and securement. Specifically, the securementSignatureKeyIdentifier property must be set to `DirectReference` in order to instruct WSS4J to generate a `BinarySecurityToken` element containing the X509 certificate and to include it in the outgoing message. The certificate's name and password are passed through the securementUsername and securementPassword properties respectively. See the next example:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="Signature"/>
    <property name="securementSignatureKeyIdentifier" value="DirectReference"/>
    <property name="securementUsername" value="mycert"/>
    <property name="securementPassword" value="certpass"/>
    <property name="securementSignatureCrypto">
      <bean class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
        <property name="keyStorePassword" value="123456"/>
        <property name="keyStoreLocation" value="classpath:/keystore.jks"/>
      </bean>
    </property>
</bean>
```

For the certificate validation, regular signature validation applies:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="Signature"/>
    <property name="validationSignatureCrypto">
      <bean class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
        <property name="keyStorePassword" value="123456"/>
        <property name="keyStoreLocation" value="classpath:/keystore.jks"/>
      </bean>
    </property>
</bean>
```

At the end of the validation, the interceptor will automatically verify the validity of the certificate by delegating to the default WSS4J implementation. If needed, this behavior can be changed by redefining the `verifyCertificateTrust` method.

For more details, please refer tothe section called “Digital Signatures”.

Security Timestamps

This section describes the various timestamp options available in the `Wss4jSecurityInterceptor`.

Validating Timestamps

To validate timestamps add `Timestamp` to the validationActions property. It is possible to override timestamp semantics specified by the initiator of the SOAP message by setting timestampStrict to `true` and specifying a server-side time to live in seconds (defaults to 300) via the timeToLive property [17] .

In the following example, the interceptor will limit the timestamp validity window to 10 seconds, rejecting any valid timestamp token outside that window:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="Timestamp"/>
    <property name="timestampStrict" value="true"/>
    <property name="timeToLive" value="10"/>
</bean>
```

Adding Timestamps

Adding `Timestamp` to the securementActions property generates a timestamp header in outgoing messages. The timestampPrecisionInMilliseconds property specifies whether the precision of the generated timestamp is in milliseconds. The default value is`true`.

[17] The interceptor will always reject already expired timestamps whatever the value of timeToLive is.

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="Timestamp"/>
    <property name="timestampPrecisionInMilliseconds" value="true"/>
</bean>
```

Digital Signatures

This section describes the various signature options available in the `Wss4jSecurityInterceptor`.

Verifying Signatures

To instruct the`Wss4jSecurityInterceptor`, validationActions must contain the `Signature` action. Additionally, the validationSignatureCrypto property must point to the keystore containing the public certificates of the initiator:

```
<bean id="wsSecurityInterceptor"
 class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="Signature"/>
    <property name="validationSignatureCrypto">
        <bean
 class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
            <property name="keyStorePassword" value="123456"/>
            <property name="keyStoreLocation" value="classpath:/keystore.jks"/>
        </bean>
    </property>
</bean>
```

Signing Messages

Signing outgoing messages is enabled by adding `Signature` action to thesecurementActions. The alias and the password of the private key to use are specified by the securementUsername and securementPassword properties respectively. securementSignatureCrypto must point to the keystore containing the private key:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="Signature"/>
    <property name="securementUsername" value="mykey"/>
    <property name="securementPassword" value="123456"/>
    <property name="securementSignatureCrypto">
        <bean
 class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
            <property name="keyStorePassword" value="123456"/>
            <property name="keyStoreLocation" value="classpath:/keystore.jks"/>
        </bean>
    </property>
</bean>
```

Furthermore, the signature algorithm can be defined via the securementSignatureAlgorithm.

The key identifier type to use can be customized via the securementSignatureKeyIdentifier property. Only `IssuerSerial` and `DirectReference` are valid for signature.

securementSignatureParts property controls which part of the message shall be signed. The value of this property is a list of semi-colon separated element names that identify the elements to sign. The

general form of a signature part is `{}{namespace}Element` [18] . The default behavior is to sign the SOAP body.

As an example, here is how to sign the `echoResponse` element in the Spring Web Services echo sample:

```
<property name="securementSignatureParts"
    value="{}{http://www.springframework.org/spring-ws/samples/echo}echoResponse"/>
```

To specify an element without a namespace use the string `Null` as the namespace name (case sensitive).

If there is no other element in the request with a local name of `Body` then the SOAP namespace identifier can be empty (`{}`).

Signature Confirmation

Signature confirmation is enabled by setting enableSignatureConfirmation to `true`. Note that signature confirmation action spans over the request and the response. This implies that `secureResponse` and `validateRequest` must be set to true (which is the default value) even if there are no corresponding security actions.

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="Signature"/>
    <property name="enableSignatureConfirmation" value="true"/>
    <property name="validationSignatureCrypto">
        <bean
 class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
            <property name="keyStorePassword" value="123456"/>
            <property name="keyStoreLocation" value="file:/keystore.jks"/>
        </bean>
    </property>
</bean>
```

Encryption and Decryption

This section describes the various encryption and descryption options available in the `Wss4jSecurityInterceptor`.

Decryption

Decryption of incoming SOAP messages requires `Encrypt` action be added to the validationActions property. The rest of the configuration depends on the key information that appears in the message [19] .

To decrypt messages with an embedded encypted symmetric key (`xenc:EncryptedKey` element), validationDecryptionCrypto needs to point to a keystore containing the decryption private key. Additionally, validationCallbackHandler has to be injected with a `org.springframework.ws.soap.security.wss4j.callback.KeyStoreCallbackHandler` specifying the key's password:

[18] The first empty brackets are used for encryption parts only.

[19] This is because WSS4J needs only a Crypto for encypted keys, whereas embedded key name validation is delegated to a callback handler.

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="Encrypt"/>
    <property name="validationDecryptionCrypto">
        <bean
 class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
            <property name="keyStorePassword" value="123456"/>
            <property name="keyStoreLocation" value="classpath:/keystore.jks"/>
        </bean>
    </property>
    <property name="validationCallbackHandler">
        <bean
 class="org.springframework.ws.soap.security.wss4j.callback.KeyStoreCallbackHandler">
            <property name="privateKeyPassword" value="mykeypass"/>
        </bean>
    </property>
</bean>
```

To support decryption of messages with an embedded *key name* (`ds:KeyName` element), configure a `KeyStoreCallbackHandler` that points to the keystore with the symmetric secret key. The property symmetricKeyPassword indicates the key's password, the key name being the one specified by `ds:KeyName` element:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="validationActions" value="Encrypt"/>
    <property name="validationCallbackHandler">
        <bean
 class="org.springframework.ws.soap.security.wss4j.callback.KeyStoreCallbackHandler">
            <property name="keyStore">
                <bean
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
                    <property name="location" value="classpath:keystore.jks"/>
                    <property name="type" value="JCEKS"/>
                    <property name="password" value="123456"/>
                </bean>
            </property>
            <property name="symmetricKeyPassword" value="mykeypass"/>
        </bean>
    </property>
</bean>
```

Encryption

Adding `Encrypt` to the securementActions enables encryption of outgoing messages. The certifacte's alias to use for the encryption is set via the securementEncryptionUser property. The keystore where the certificate reside is accessed using the securementEncryptionCrypto property. As encryption relies on public certificates, no password needs to be passed.

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="Encrypt"/>
    <property name="securementEncryptionUser" value="mycert"/>
    <property name="securementEncryptionCrypto">
        <bean
 class="org.springframework.ws.soap.security.wss4j.support.CryptoFactoryBean">
            <property name="keyStorePassword" value="123456"/>
            <property name="keyStoreLocation" value="file:/keystore.jks"/>
        </bean>
    </property>
</bean>
```

Encryption can be customized in several ways: The key identifier type to use is defined bysecurementEncryptionKeyIdentifier. Possible values are`IssuerSerial`,`X509KeyIdentifier`, `DirectReference`,`Thumbprint`, `SKIKeyIdentifier` or`EmbeddedKeyName`.

If the `EmbeddedKeyName` type is chosen, you need to specify the *secret key* to use for the encryption. The alias of the key is set via the securementEncryptionUser property just as for the other key identifier types. However, WSS4J requires a callback handler to fetch the secret key. Thus, securementCallbackHandler must be provided with a `KeyStoreCallbackHandler` pointing to the appropriate keystore. By default, the `ds:KeyName` element in the resulting WS-Security header takes the value of the securementEncryptionUser property. To indicate a different name, set the securementEncryptionEmbeddedKeyName with the desired value. In the next example, the outgoing message will be encrypted with a key aliased `secretKey` whereas `myKey` will appear in `ds:KeyName` element:

```
<bean class="org.springframework.ws.soap.security.wss4j.Wss4jSecurityInterceptor">
    <property name="securementActions" value="Encrypt"/>
    <property name="securementEncryptionKeyIdentifier" value="EmbeddedKeyName"/>
    <property name="securementEncryptionUser" value="secretKey"/>
    <property name="securementEncryptionEmbeddedKeyName" value="myKey"/>
    <property name="securementCallbackHandler">
        <bean
 class="org.springframework.ws.soap.security.wss4j.callback.KeyStoreCallbackHandler">
            <property name="symmetricKeyPassword" value="keypass"/>
            <property name="keyStore">
                <bean
 class="org.springframework.ws.soap.security.support.KeyStoreFactoryBean">
                    <property name="location" value="file:/keystore.jks"/>
                    <property name="type" value="jceks"/>
                    <property name="password" value="123456"/>
                </bean>
            </property>
        </bean>
    </property>
</bean>
```

The securementEncryptionKeyTransportAlgorithm property defines which algorithm to use to encrypt the generated symmetric key. Supported values are `http://www.w3.org/2001/04/xmlenc#rsa-1_5`, which is the default, and `http://www.w3.org/2001/04/xmlenc#rsa-oaep-mgf1p`.

The symmetric encryption algorithm to use can be set via the securementEncryptionSymAlgorithm property. Supported values are `http://www.w3.org/2001/04/xmlenc#aes128-cbc` (default value), `http://www.w3.org/2001/04/xmlenc#tripledes-cbc`, `http://www.w3.org/2001/04/xmlenc#aes256-cbc`, `http://www.w3.org/2001/04/xmlenc#aes192-cbc`.

Finally, the securementEncryptionParts property defines which parts of the message will be encrypted. The value of this property is a list of semi-colon separated element names that identify the elements to encrypt. An encryption mode specifier and a namespace identification, each inside a pair of curly brackets, may precede each element name. The encryption mode specifier is either `{Content}` or `{Element}` [20] . The following example identifies the `echoResponse` from the echo sample:

```
<property name="securementEncryptionParts"
    value="{Content}{http://www.springframework.org/spring-ws/samples/echo}echoResponse"/>
```

[20] Please refer to the W3C XML Encryption specification about the differences between Element and Content encryption.

Be aware that the element name, the namespace identifier, and the encryption modifier are case sensitive. The encryption modifier and the namespace identifier can be omitted. In this case the encryption mode defaults to `Content` and the namespace is set to the SOAP namespace.

To specify an element without a namespace use the value `Null` as the namespace name (case sensitive). If no list is specified, the handler encrypts the SOAP Body in `Content` mode by default.

Security Exception Handling

The exception handling of the `Wss4jSecurityInterceptor` is identical to that of the `XwsSecurityInterceptor`. See the section called “Security Exception Handling” for more information.

Part III. Other Resources

In addition to this reference documentation, there exist a number of other resources that may help you learn how to use Spring Web Services. These additional, third-party resources are enumerated in this section.

Bibliography

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