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Design and implement POJO Web services using Spring and Apache CXF, Part 1: Introduction to Web services creation using CXF and Spring

Skill Level: Intermediate

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Create a plain old Java™ object (POJO)-style Web service easily using Apache CXF, an open source Web service framework. This article, Part 1 of a series, shows you how to expose POJOs as Web services using Spring and CXF. It also illustrates CXF integration with the Spring Framework.

Introduction

In this article, you build and develop an order-processing Web service using CXF and Spring. This Web service processes or validates the order placed by a customer and returns the unique order ID. After reading this article, you can apply the concepts and features of CXF to build and develop a Web service.

System requirements

To run the examples in this article, make sure the following software is installed and set up on your machine:

- Java 5 or higher
- Tomcat 5 or higher

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- Ant build tool
- CXF binary distribution 2.1

After the above distribution is installed, set up the following environment variables:

- JAVA_HOME (for Java)
- CATALINA_HOME (for Tomcat)
- ANT_HOME (for Ant)
- CXF_HOME (for CXF)

By way of example, set CXF_HOME=C:\apache-cxf-2.1 and add the following to the PATH env variable:

- JAVA_HOME\bin
- CATALINA_HOME\bin
- ANT_HOME\bin

Why CXF?

Apache CXF is an open source framework that provides a robust infrastructure for conveniently building and developing Web services. It lets you create high-performance and extensible services, which you can deploy in the Tomcat and Spring-based lightweight containers as well as on a more advanced server infrastructure, such as JBoss, IBM® WebSphere®, or BEA WebLogic.

Features

The framework provides the following features:

- **Web services standards support:** CXF supports the following Web services standards:
    - Java API for XML Web Services (JAX-WS)
    - SOAP
    - Web Services Description Language (WSDL)
    - Message Transmission Optimization Mechanism (MTOM)
    - WS-Basic Profile
    - WS-Addressing

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    - WS-Policy
    - WS-ReliableMessaging
    - WS-Security
- **Front-end modeling:** CXF provides the concept of front-end modeling, which lets you create Web services using different front-end APIs. The APIs lets you create a Web service using simple factory beans and through a JAX-WAS implementation. It also lets you create dynamic Web service clients.
- **Tools support:** CXF provides different tools for conversion between Java beans, Web services, and WSDL. It provides support for Maven and Ant integration, and seamlessly supports Spring integration.
- **Support of RESTful services:** CXF supports the concept of RESTful (Representational State Transfer) services and supports a JAX-RS implementation for the Java platform. (Part 2 in this series will provide more information about RESTful services.)
- **Support for different transport and bindings:** CXF supports different kinds of transports, from XML to Comma Separated Values (CSVs). It also supports Java Architecture for XML Binding (JAXB) and AEGIS data binding apart from SOAP and HTTP protocol binding.
- **Support for non-XML binding:** CXF supports non-XML bindings, such as JavaScript Object Notation (JSON) and Common Object Request Broker Architecture (CORBA). It also supports the Java Business Integration (JBI) architectures and Service Component Architectures (SCAs).

Develop a Web service

Let's look specifically at how to create an order-processing Web service and then register it as a Spring bean using a JAX-WS front end. You use the code-first approach, which means you first develop a Java class and annotate it as a Web service. To do this, you typically perform the following steps:

1. Create a service endpoint interface (SEI) and define a method to be exposed as a Web service.
2. Create the implementation class and annotate it as a Web service.
3. Create beans.xml and define the service class as a Spring bean using a JAX-WS front end.

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4. Create web.xml to integrate Spring and CXF.

First let's create the order-processing Web service SEI.

Create the order-processing Web service SEI

Create an SEI named `OrderProcess`, which will have a method, `processOrder`, that takes an order bean and returns a string. The goal of the `processOrder` method is to process the order placed by the customer and return the unique order ID.

Listing 1. OrderProcess SEI

```
package demo.order;

import javax.jws.WebService;

@WebService
public interface OrderProcess {
  String processOrder(Order order);
}
```

As you can see in Listing 1, the `OrderProcess` SEI is simply a standard Java interface that's annotated as a Web service. The `@WebService` annotation simply makes the interface a Web service interface. This interface is used by the client or the consumer to invoke the service method. The `OrderProcess` SEI has one service method, `processOrder`, which takes `Order` as a parameter and returns the order ID as a string.

Listing 2. OrderProcess service implementation

```
package demo.order;

import javax.jws.WebService;

@WebService(endpointInterface = "demo.order.OrderProcess")
public class OrderProcessImpl implements OrderProcess {

 public String processOrder(Order order) {
  return order.validate();
 }
}
```

Write the implementation of the SEI

To write the implementation of the SEI in the previous section, you again annotate your implementation class, `OrderProcessImpl`, as a Web service and provide an attribute, `endpointInterface`, with a value as a fully qualified name of the SEI you created in the previous step. This tells the class to implement the `OrderProcess` SEI. Because it's an implementation of an SEI, you have to provide

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implementation of the `processOrder` method that returns the order ID.

You've created an SEI and its implementation. Using CXF, now you can make this an actual service component using a JAX-WS front end.

Listing 3. beans.xml configuration file

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

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

 <jaxws:endpoint
  id="orderProcess"
  implementor="demo.order.OrderProcessImpl"
  address="/OrderProcess" />

</beans>
```

Create a configuration file for CXF

A CXF configuration file is actually a Spring configuration file that contains bean definitions. You create a bean definition for the `OrderProcess` Web service using JAX-WS front-end configuration. The `<jaxws:endpoint>` tag in the beans.xml file specifies the `OrderProcess` Web service as a JAX-WS endpoint. It effectively means that CXF internally uses JAX-WS to publish this Web service. You have to provide the implementation class name, which is `OrderProcessImpl`, and the address to the `<jaxws:endpoint>` tag. The address that you provide is relative to the Web context.

Listing 4. web.xml Web configuration file

```
<web-app>
 <context-param>
  <param-name>contextConfigLocation</param-name>
  <param-value>WEB-INF/beans.xml</param-value>
 </context-param>

 <listener>
  <listener-class>
   org.springframework.web.context.ContextLoaderListener
  </listener-class>
 </listener>

 <servlet>
```


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```
  <servlet-name>CXFServlet</servlet-name>
  <display-name>CXF Servlet</display-name>
  <servlet-class>
   org.apache.cxf.transport.servlet.CXFServlet
  </servlet-class>
  <load-on-startup>1</load-on-startup>
 </servlet>

 <servlet-mapping>
  <servlet-name>CXFServlet</servlet-name>
  <url-pattern>/*</url-pattern>
 </servlet-mapping>
</web-app>
```

Finally you need to:

- Create the web.xml file, which loads the CXF configuration file.
- Use the Spring context loader to load the configuration file.
- Register a CXFServlet to handle all the requests coming from the client program.

You've just finished developing the necessary server-side components. Now you can develop a client component that makes a request to the `OrderProcess` service.

Develop a client

As you can see from Listing 5, it's very easy to create the client bean, just as it was easy to create the service endpoint. `JaxWsProxyFactory` is used to create the client bean for the `OrderProcess` Web service. The factory bean expects the service class (`OrderProcess`) and the URL of your service. The client bean stub, `OrderProcess`, is then created by using the factory bean reference.

Listing 5. client-bean.xml client Web configuration file

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

 <bean id="client" class="demo.order.OrderProcess"
  factory-bean="clientFactory" factory-method="create"/>

 <bean id="clientFactory"
class="org.apache.cxf.jaxws.JaxWsProxyFactoryBean">
  <property name="serviceClass"
value="demo.order.OrderProcess"/>
  <property name="address"
value="http://localhost:8080/orderapp/OrderProcess"/>
 </bean>
```


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```
</beans>
```

You create a Java main program that uses the Spring context to get the client bean defined, then invoke the `processOrder` method.

Listing 6. The client code

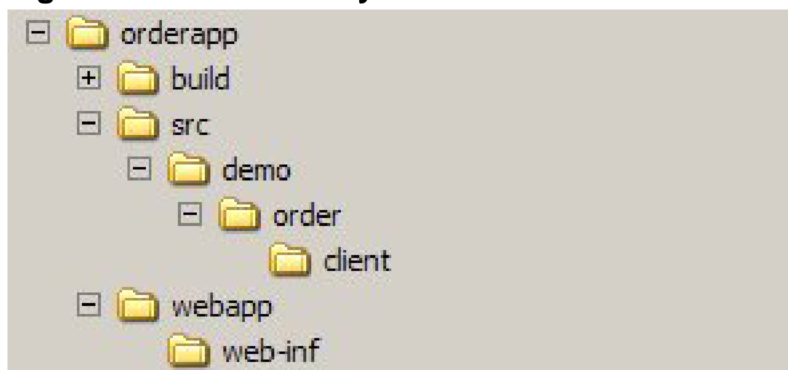
```
public final class Client {

 public Client() {
 }

 public static void main(String args[]) throws Exception {
  ClassPathXmlApplicationContext context
   = new ClassPathXmlApplicationContext(new String[]
     {"demo/order/client/client-beans.xml"});

  OrderProcess client =
(OrderProcess)context.getBean("client");
    Order order = new Order();

  String orderID = client.processOrder(order);
  System.out.println("Order ID: " + orderID);
  System.exit(0);
 }
}
```

Run the program

Before running the program, create the directory structure shown in Figure 1 under your root C:\ folder and put the components covered previously in this article into it:

- The Java code goes into the package folders.
- beans.xml and web.xml go into the web\web-inf folder.
- client-beans.xml will go into demo\order\client folder.

Figure 1. Code directory structure



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For building, deploying, and running the `OrderProcess` Web service and client, you use the Ant tool. The code is deployed on the Tomcat server. Deploy the code using the `ant deploy` command under the c:\orderapp folder.

The application folder (c:\orderapp) has the Ant build files. After running the above command, your `orderapp` code is deployed in the Tomcat server environment as the orderapp.war file. Now start the Tomcat Web server by providing the `catalina start` command under the CATALINA_HOME\bin folder.

The orderapp folder is created under the webapps folder of Tomcat. After the server is started, run the application by entering the `ant client` command. The output displays the order ID (see Figure 2).

Figure 2. Program output

```
C:\orderapp>ant client
Buildfile: build.xml

maybe.generate.code:

compile:

build:

client:
     [java] Order ID: ORD1234

BUILD SUCCESSFUL
Total time: 4 seconds
```

Conclusion

This article briefly described the features of the CXF framework and demonstrated how it lets you create a Web service without much coding effort. You learned about Spring integration with CXF using a bean context file. You also looked at how the framework abstracts the actual semantics of creating a Web service infrastructure component and provides you with a shell of a simpler API that simply focuses on Web service creation.

Now that you've seen the basics of Web service creation using CXF, stay tuned for Part 2 of this series, which will show you how to expose POJOs as Restful services using CXF and Spring.

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Downloads

Description	Name	Size	Download method
Order application	orderapp.zip	11KB	HTTP

Information about download methods

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Resources

Learn

- Take the tutorial "Design and develop JAX-WS 2.0 Web services" (developerWorks, Sep 2007) for a step-by-step guide to developing Web services using JAX-WS technology.
- Read the book *Hands on Web Services* for comprehensive hands-on information about how to design and develop real-world Web services applications.
- Check out the article "Web services architecture using MVC style" (developerWorks, Feb 2002) to learn how you can apply the Model-View-Controller (MVC) architecture to invoke static or dynamic Web services.
- "Deliver Web services to mobile apps" (developerWorks, Jan 2003) explains how to access Web services using Java 2 Platform, Micro Edition (J2ME)-enabled mobile devices.
- The SOA and Web services zone on IBM developerWorks hosts hundreds of informative articles and introductory, intermediate, and advanced tutorials on how to develop Web services applications.
- Play in the IBM SOA Sandbox! Increase your SOA skills through practical, hands-on experience with the IBM SOA entry points.
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