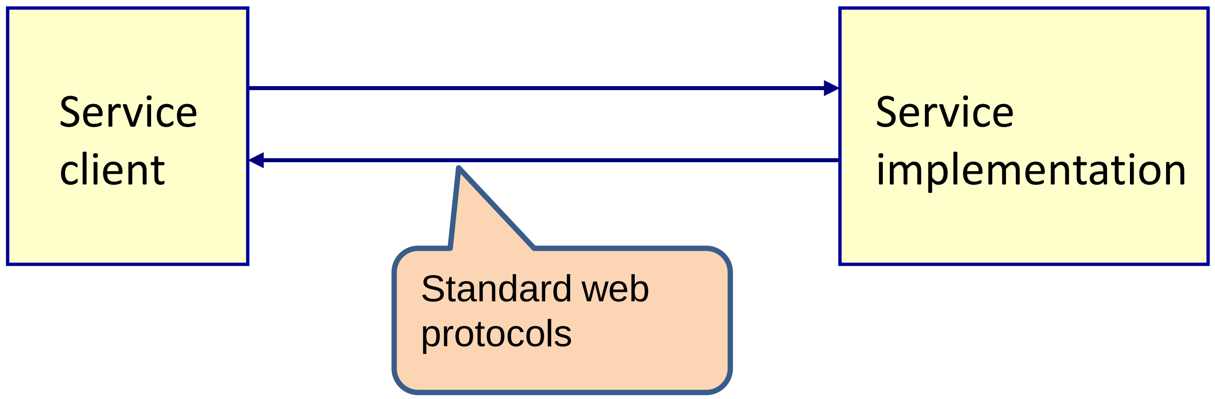
Spring Web Services

CS544: Enterprise Architecture

Spring Web Services:

BASICS OF WEBSERVICES

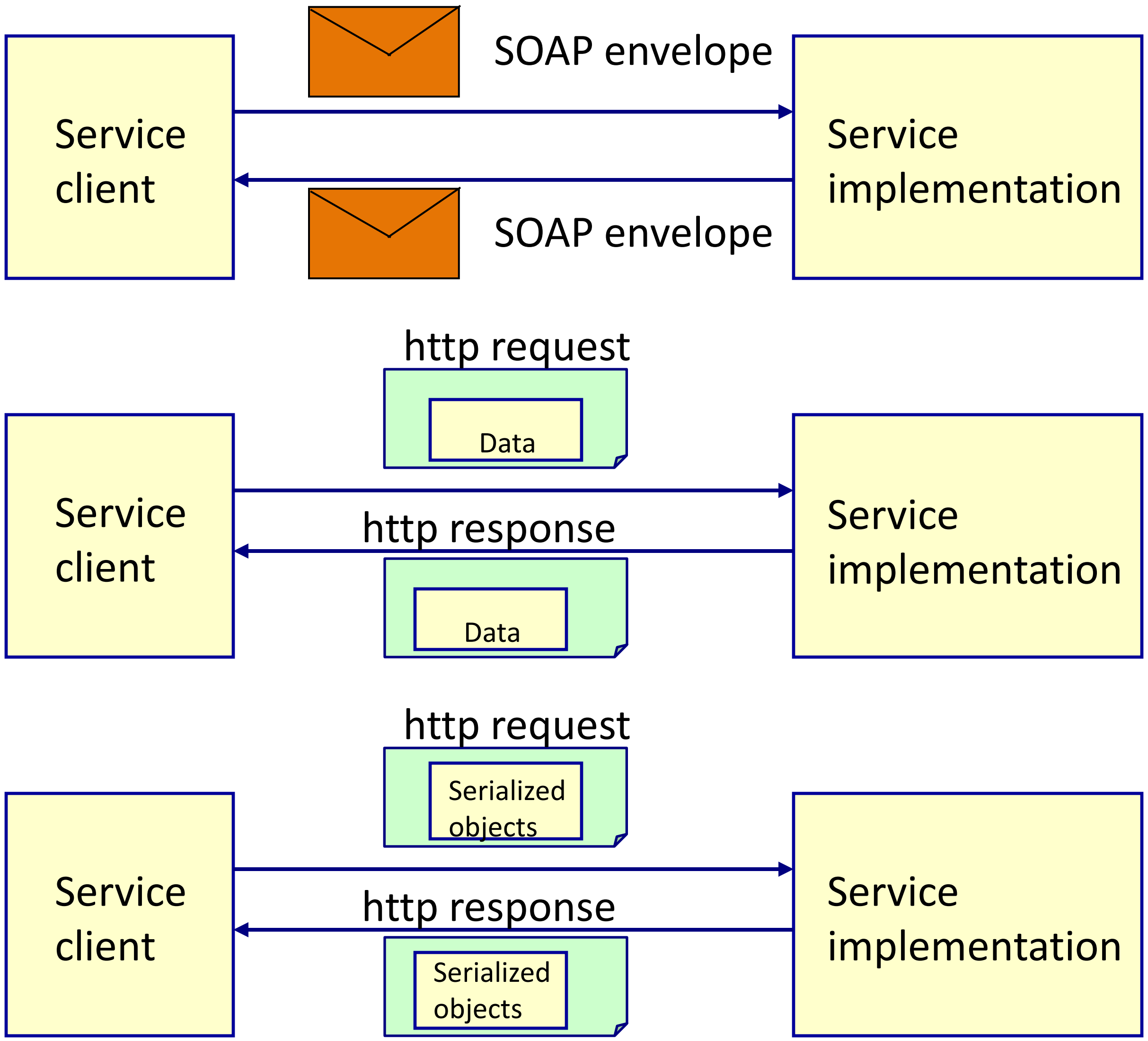
What is a Web Service?



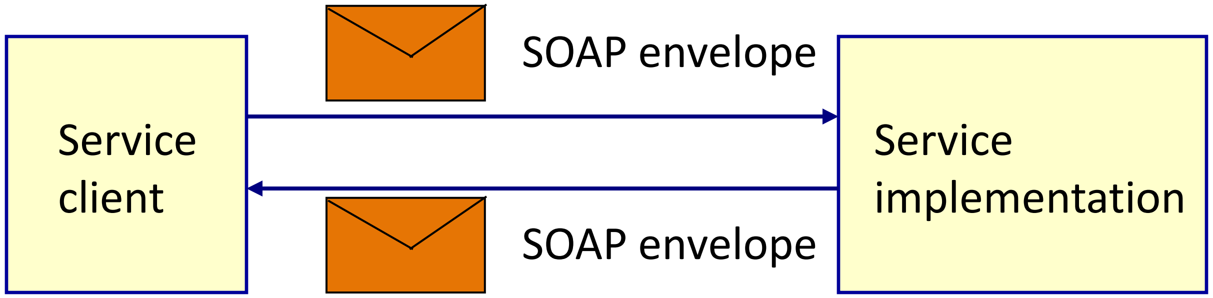
- A web service offers functionality that can be called by other clients using standard web protocols (SOAP, XML, HTTP)

Types of Web Services

- SOAP
- REST
- Serialized objects

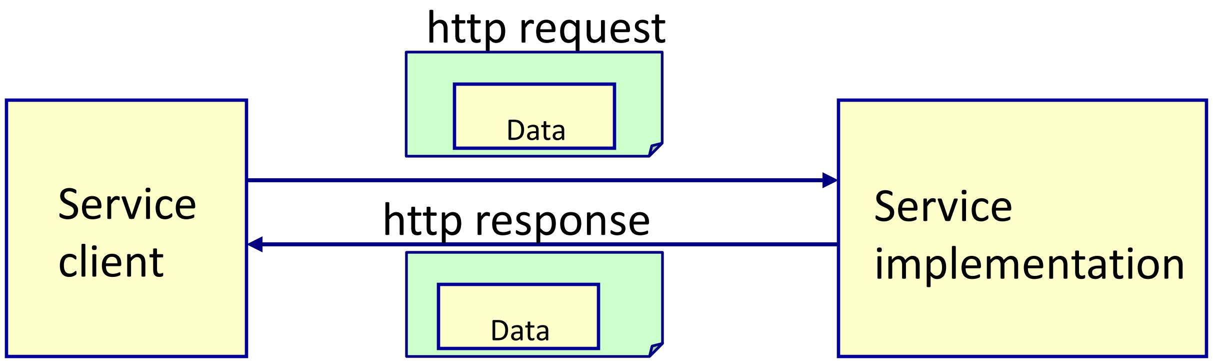


SOAP Web Services



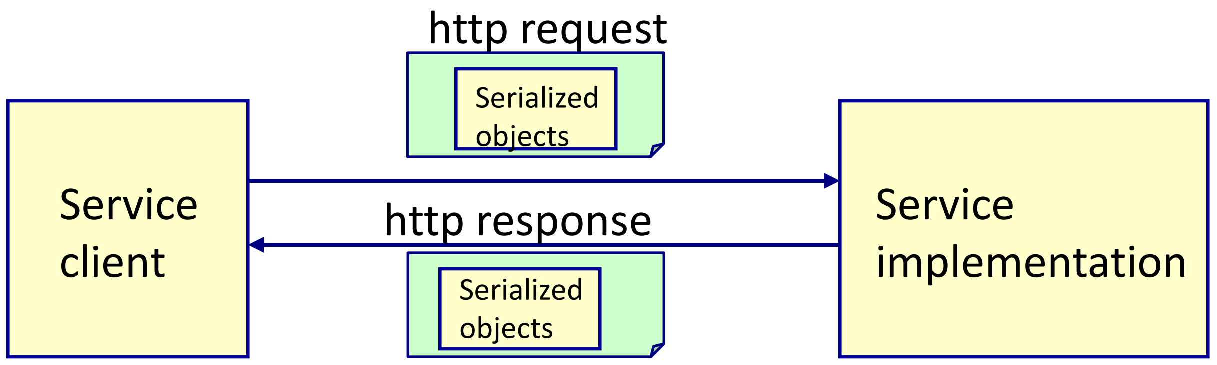
- WSDL interface description
- Contract first vs contract last
- SOAP frameworks
  - Axis2
  - CXF
  - Spring-WS

RESTful Web Services



- Data in HTTP messages
  - GET message for retrieving data
  - POST message for creating data
  - PUT message for updating data
  - DELETE message for deleting data

Serialized objects



- If the client and server are both Java
- Sending serialized object is faster than sending XML
- Like RMI over HTTP

Examples of Web Services with Spring

- This module is devided into the following sections:

1. Spring REST support
2. Spring-WS SOAP webservices
3. Spring HTTPInvoker

Spring Web Services:

SPRING REST WITH JSON

JSON

- If the jackson library is on the class path SpringMVC will automatically configure the:
  - MappingJackson2HttpMessageConverter
    - converts Java Objects to JSON
    - And JSON to Java Objects

```
<dependency>
   <groupId>com.fasterxml.jackson.core</groupId>
   <artifactId>jackson-databind</artifactId>
   <version>2.9.6</version>
</dependency>
```

@RestController Example

```
@RestController
public class Test {

    @GetMapping("/test")
    public Person output() {
        return new Person("Test", 28);
    }

    @PostMapping("/test")
    public void input(@RequestBody Person test) {
        System.out.println(test);
    }
}
```

Outputs:
{“name”: “Test”, “age”: 28}

Expects application/json input:
{“name”: “Test”, “age”: 28}

Spring Web Services:

SPRING REST WITH XML

RESTful Web Services

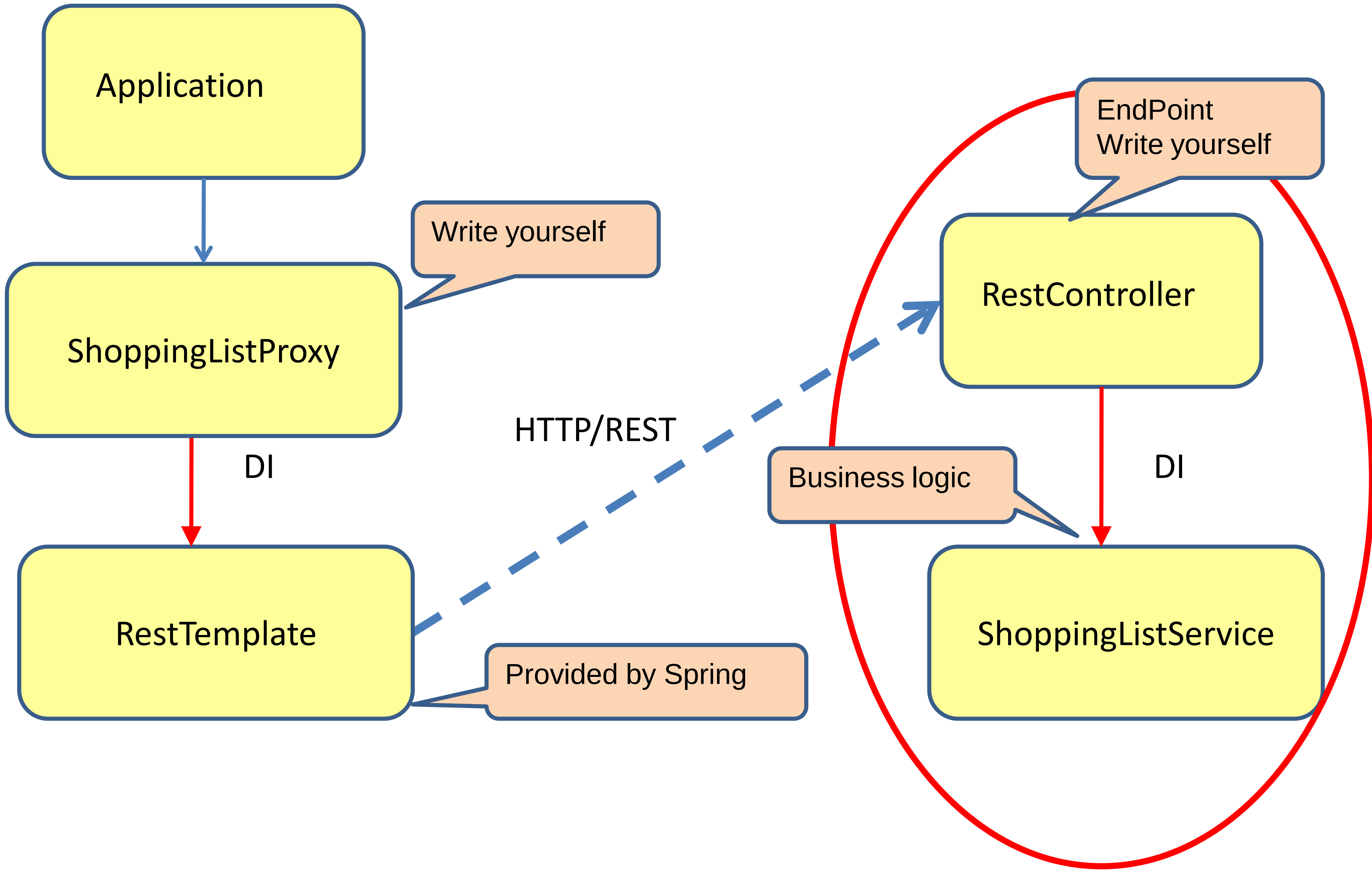
- RESTful Web Services are closely tied to the HTTP protocol
  - Not bound to a specific data format
  - The URL specifies the resource to act on
  - The HTTP method specifies the action type
    - GET method for retrieving data
    - POST method for creating data
    - PUT method for updating data
    - DELETE method for deleting data

Shopping List Example

- Shopping List RESTful Web Service
  - Chosen to use XML as our data format
  - GET /list returns entire shopping list
  - POST /list to add an item to the list
  - GET /item/{product} returns item details
  - PUT /item/{product} to update an item
  - DELETE /item/{product} to delete an item

- Where {product} is a variable string, e.g. /item/Tomatoes or /item/Avacados

The Server


Application
Write yourself
ShoppingListProxy
DI
HTTP/REST
RestTemplate
Provided by Spring
EndPoint
Write yourself
RestController
DI
Business logic
ShoppingListService

JAXB O/X Mapping

- We will use JAXB again for our O/X mapping
- This gives us roughly the same 3 steps as our previous Spring WS example
    1. Write example XML messages
    2. Generate Java based on this XML
    3. Write the Web Service Endpoint, a Service Implementation and a Spring configuration

1: Example XML Messages

- Sample ShoppingList:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<shopping-list xmlns="http://springtraining/shopping-list">
  <item qty="1" notes="Either organic or non-organic">Lemons</item>
  <item qty="3" notes="Organic is better">Tomatoes</item>
  <item qty="2" notes="Both black and green">Olives</item>
  <item qty="2" notes="Not too ripe">Avocados</item>
</shopping-list>
```

- Sample Item:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<item qty="3" notes="Organic is better">Tomatoes</item>
```

2: Generated ShoppingList

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "", propOrder = {"item"})
@XmlRootElement(name = "shopping-list")
public class ShoppingList {

  protected Collection<Item> item;

  public ShoppingList() {
  }
  public ShoppingList(Collection<Item> item) {
    this.item = item;
  }

  public Collection<Item> getItem() {
    if (item == null) {
      item = new ArrayList<Item>();
    }
    return this.item;
  }
  public String toString() {
    String result = "";
    for (Item itm : item) {
      result += String.format("%2d %-20s %-20s\n", itm.getQty(), itm.getProduct(),
          itm.getNotes());
    }
    return result;
  }
}
```

JAXB annotations

Collection of Items is its only attribute.

Attribute name has to be "item" for JAXB to create the correct tags name

Added convenience constructor

Added a toString method for easy printing of the list

Generated Item Class

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "", propOrder = {"product”})
@XmlRootElement(name = "item")
public class Item {

  @XmlValue
  protected String product;
  @XmlAttribute
  protected Integer qty;
  @XmlAttribute
  protected String notes;

  public Item() {
  }

  public Item(String product, Integer qty, String notes) {
    this.product = product;
    this.qty = qty;
    this.notes = notes;
  }

  ...
```

JAXB annotations

Item has three attributes: product, qty and notes

Default constructor and an added convenience constructor

Item Class Continued

```
public String getProduct() {
   return product;
 }

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

 public Integer getQty() {
   return qty;
 }

 public void setQty(Integer value) {
   this.qty = value;
 }

 public String getNotes() {
   return notes;
 }

 public void setNotes(String value) {
   this.notes = value;
 }
}
```

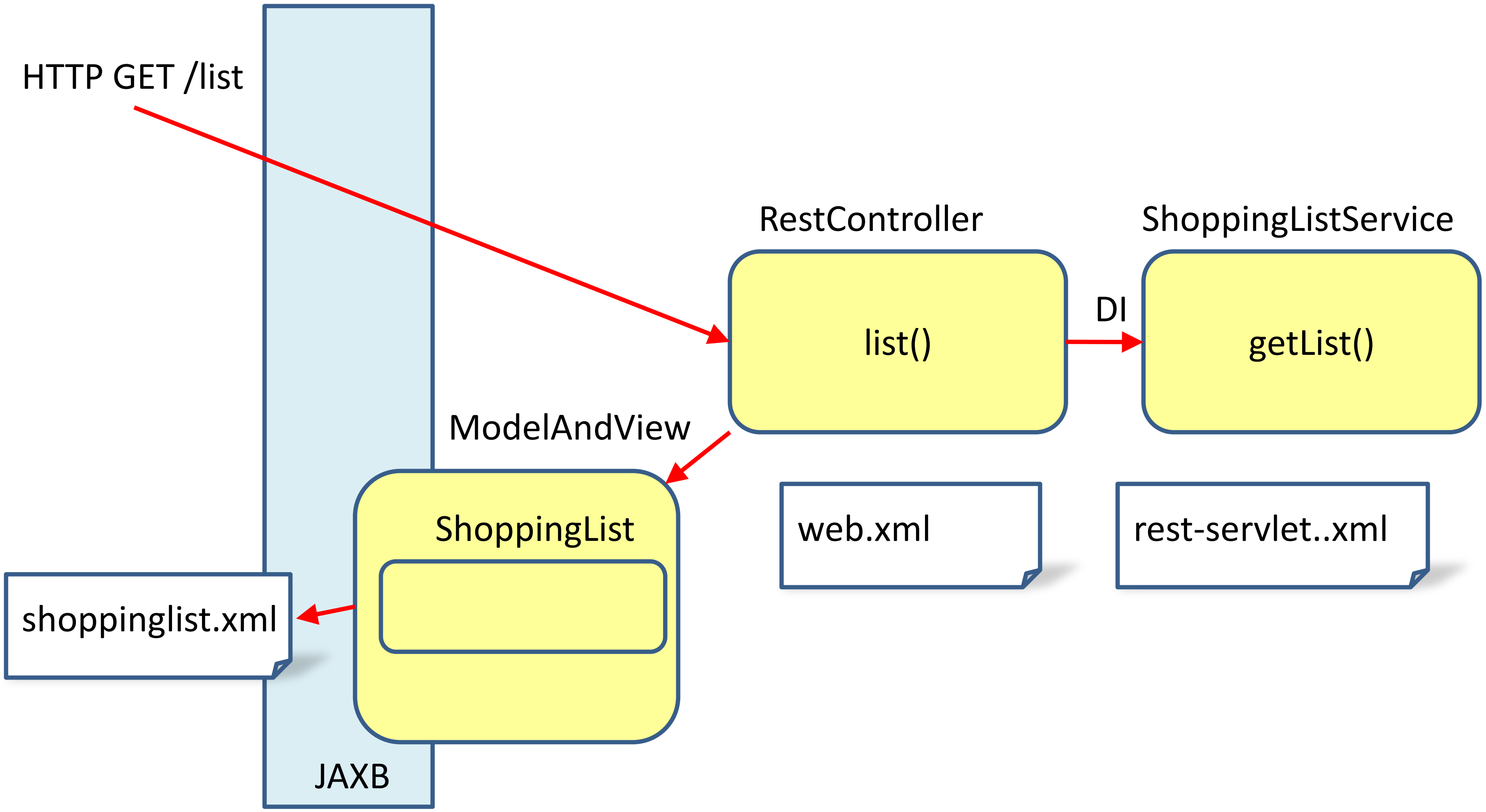
Generated Getters and Setter

3: Implementation

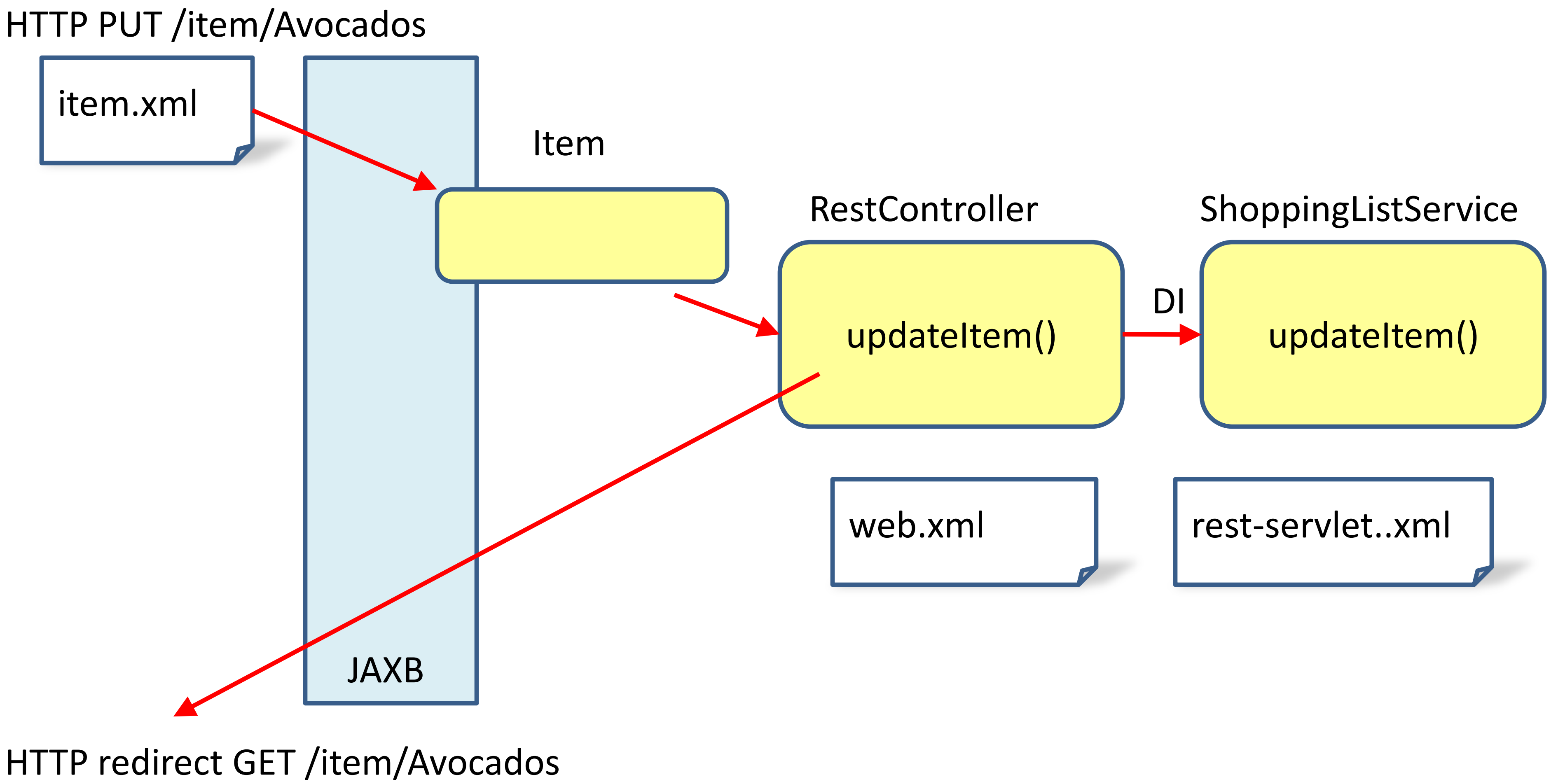
- The Service implementation has 3 parts
  1. The shopping list service class
  2. The Web Service endpoint
  3. Spring and web configurations

- The Service class implements the business logic
- The Web Service endpoint provides the RESTful interface to this logic
- The configurations bind it all together

HTTP GET /list



HTTP PUT /item/Avocados



Shopping ListService

```
public class ShoppingListService implements IShoppingListService {
  private Map<String, Item> items = new HashMap<String, Item>();

  public ShoppingList getList() {
    return new ShoppingList(items.values());
  }

  public Item getItem(String product) {
    return items.get(product);
  }

  public void addToList(Item item) {
    if (items.containsKey(item.getProduct())) {
      Item current = items.get(item.getProduct());
      current.setQty(current.getQty() + item.getQty());
      if (!current.getNotes().equals(item.getNotes())) {
        current.setNotes(current.getNotes() + "\n" + item.getNotes());
      }
    } else {
      items.put(item.getProduct(), item);
    }
  }

  public void removeFromList(String product) {
    items.remove(product);
  }
  public void updateItem(Item item) {
    items.put(item.getProduct(), item);
  }
}
```

Map to hold shoppingList data

IShoppingListService

```
public interface IShoppingListService {

  public ShoppingList getList();
  public Item getItem(String product);
  public void addToList(Item item);
  public void removeFromList(String product);
  public void updateItem(Item item);

}
```

RestController (endpoint)

```
@Controller
public class RestController {
  private ShoppingListService shoppingListService;
  public void setShoppingService(ShoppingListService shoppingListService) {
    this.shoppingListService = shoppingListService;
  }


  @RequestMapping(value = "/list", method = RequestMethod.GET)
  public ModelAndView list() {
    ModelAndView mav = new ModelAndView();
    mav.setViewName("marshalview ");
    mav.addObject("list", shoppingListService.getList());
    return mav;
  }


  ...
```

MVC @Controller annotation

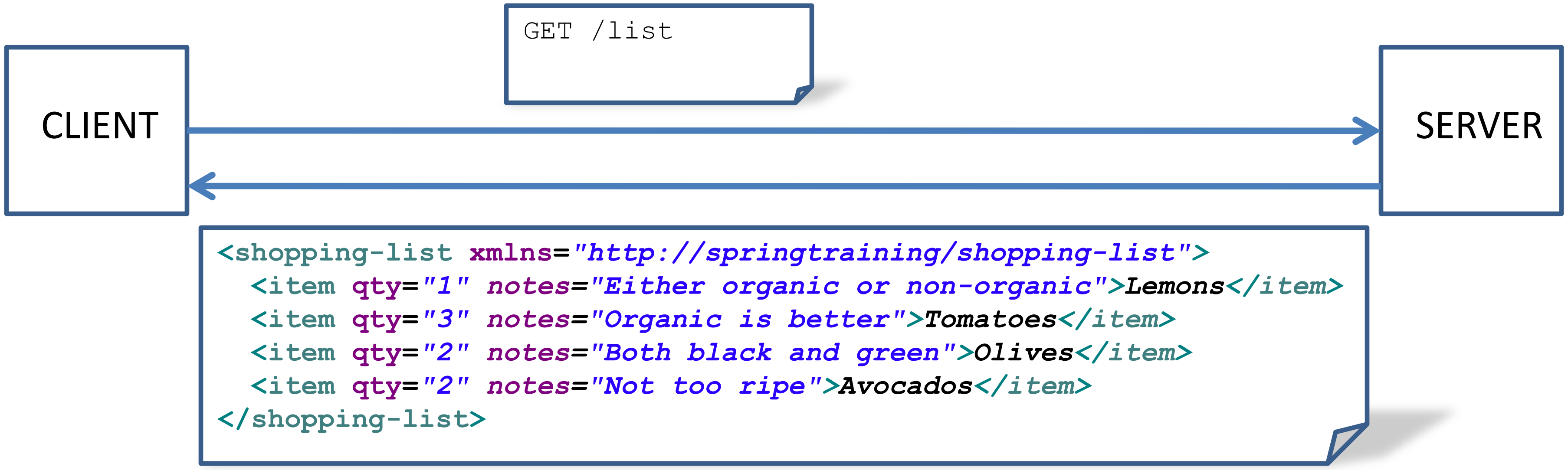
DI ShoppingListService

@RequestMapping for GET

Show view “marshalview”

Put ShoppingList in Model

GET method for all items



```
GET /list
```

```xml
<shopping-list xmlns="http://springtraining/shopping-list">
  <item qty="1" notes="Either organic or non-organic">Lemons</item>
  <item qty="3" notes="Organic is better">Tomatoes</item>
  <item qty="2" notes="Both black and green">Olives</item>
  <item qty="2" notes="Not too ripe">Avocados</item>
</shopping-list>
```

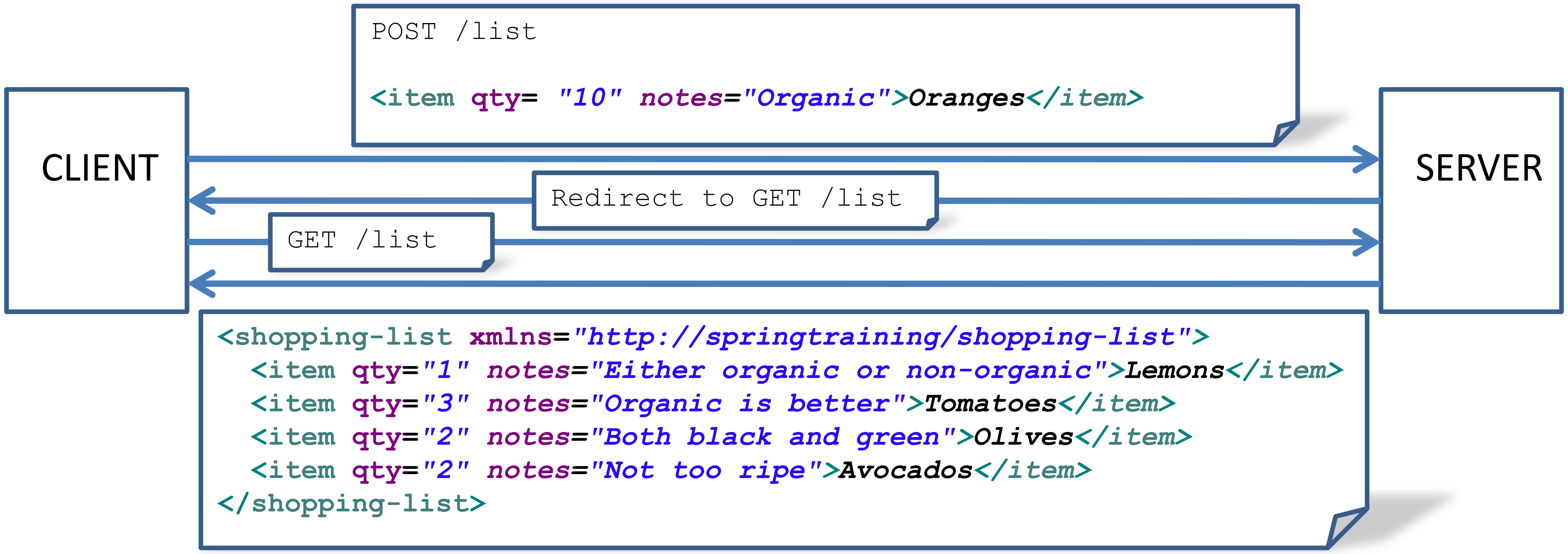
```java
@RequestMapping(value = "/list", method = RequestMethod.GET)
public ModelAndView list() {
  ModelAndView mav = new ModelAndView();
  mav.setViewName("marshalview");
  mav.addObject("list", shoppingListService.getList());
  return mav;
}
```

@RequestMapping for GET

Show view "marshalview"

Put ShoppingList in Model

POST method



```
POST /list

<item qty= "10" notes="Organic">Oranges</item>
```

```
<shopping-list xmlns="http://springtraining/shopping-list">
  <item qty="1" notes="Either organic or non-organic">Lemons</item>
  <item qty="3" notes="Organic is better">Tomatoes</item>
  <item qty="2" notes="Both black and green">Olives</item>
  <item qty="2" notes="Not too ripe">Avocados</item>
</shopping-list>
```

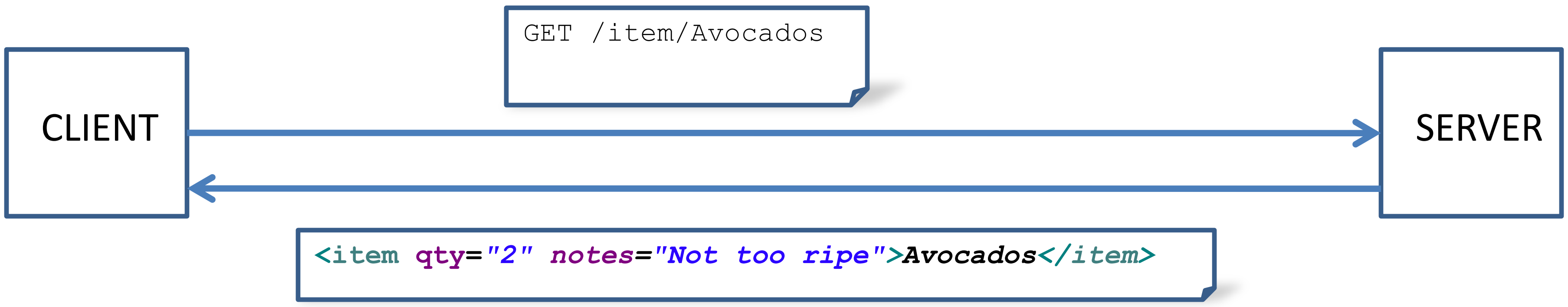
@RequestMapping for POST

```
@RequestMapping(value = "/list", method = RequestMethod.POST)
public RedirectView addItem(@RequestBody Item item) {
  shoppingListService.addToList(item);
  return new RedirectView("list");
}
```

Add Item to list

Redirect back to GET “list”

GET method for 1 item



```
GET /item/Avocados
```

```
<item qty="2" notes="Not too ripe">Avocados</item>
```

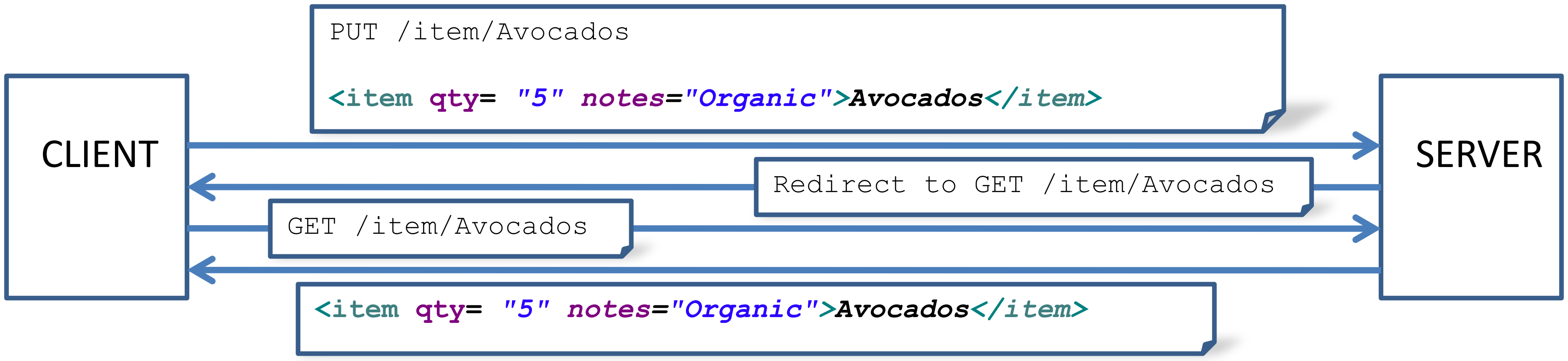
@RequestMapping for GET

```
@RequestMapping(value = "/item/{product}*", method = RequestMethod.GET)
public ModelAndView item(@PathVariable("product") String product) {
  ModelAndView mav = new ModelAndView();
  mav.setViewName("marshalview");
  Item item = shoppingListService.getItem(product);
  if (item != null) {
    mav.addObject("item", item);
  }
  return mav;
}
```

Set “marshalview” view

Add requested item to the model

PUT method

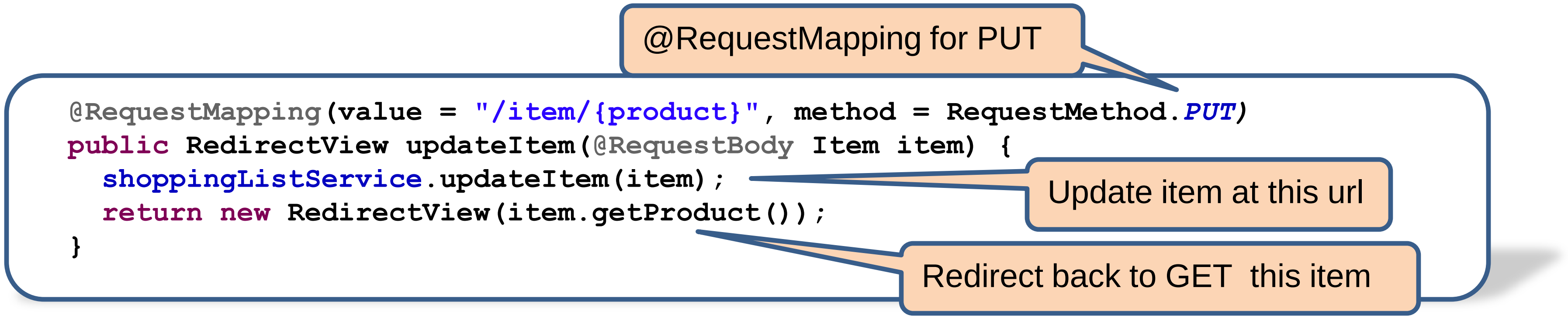


```
PUT /item/Avocados

<item qty= "5" notes="Organic">Avocados</item>
```

```
Redirect to GET /item/Avocados
```

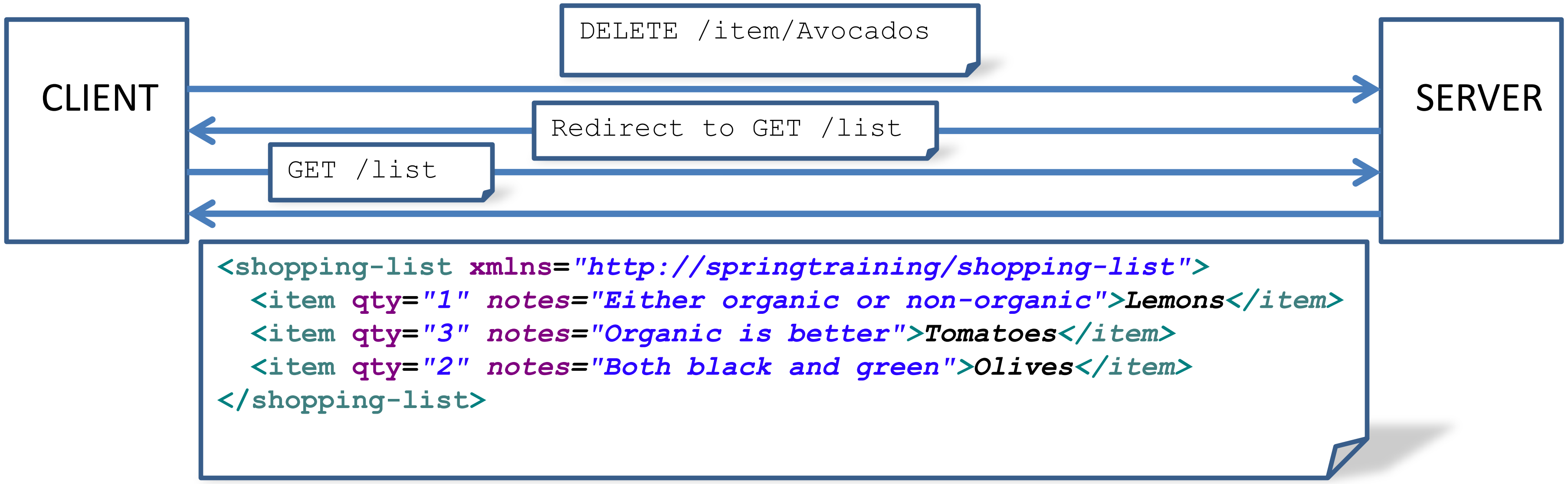
```
GET /item/Avocados
```

```
<item qty= "5" notes="Organic">Avocados</item>
```



```
@RequestMapping(value = "/item/{product}", method = RequestMethod.PUT)
public RedirectView updateItem(@RequestBody Item item) {
  shoppingListService.updateItem(item);
  return new RedirectView(item.getProduct());
}
```

DELETE method



```xml
<shopping-list xmlns="http://springtraining/shopping-list">
  <item qty="1" notes="Either organic or non-organic">Lemons</item>
  <item qty="3" notes="Organic is better">Tomatoes</item>
  <item qty="2" notes="Both black and green">Olives</item>
</shopping-list>
```

@RequestMapping for DELETE

```java
@RequestMapping(value = "/item/{product}", method = RequestMethod.DELETE)
public RedirectView deleteItem(@PathVariable("product") String product) {
  shoppingListService.removeFromList(product);
  return new RedirectView("../list");
}
```

Remove item at this url

Redirect back to GET the list

../list is a relative url, pointing one level lower (away from the item directory) to the list

web.xml

```
<web-app ... version="2.5">

  <display-name>module13Example-REST</display-name>

  <servlet>
    <servlet-name>rest</servlet-name>
    <servlet-class>org.springframework.web.servlet.DispatcherServlet</servlet-class>
    <load-on-startup>1</load-on-startup>
  </servlet>

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

</web-app>
```

rest-servlet.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:p="http://www.springframework.org/schema/p"
xmlns:util="http://www.springframework.org/schema/util"
xmlns:context="http://www.springframework.org/schema/context"
xsi:schemaLocation="
       http://www.springframework.org/schema/beans
       http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
       http://www.springframework.org/schema/util
       http://www.springframework.org/schema/util/spring-
       http://www.springframework.org/schema/context
       http://www.springframework.org/schema/context/spri

  <context:component-scan base-package="demo"/>

  <bean id="shoppingListService" class="demo.ShoppingListService"/>

  <bean id="restController" class="demo.RestController">
    <property name="shoppingListService" ref="shoppingListService"/>
  </bean>

  <bean class="org.springframework.web.servlet.view.BeanNameViewResolver"/>

  <bean id="marshaller" class="org.springframework.oxm.jaxb.Jaxb2Marshaller">
    <property name="contextPath" value="generated"/>
  </bean>

  ...
```

Scan all files in the demo pacakge for classes with @Controller annotations an map their @RequestMappings

DI the shoppingListService into our restController

Resolves view names to beans

The JAXB O/X mapping framework

rest-servlet.xml Continued

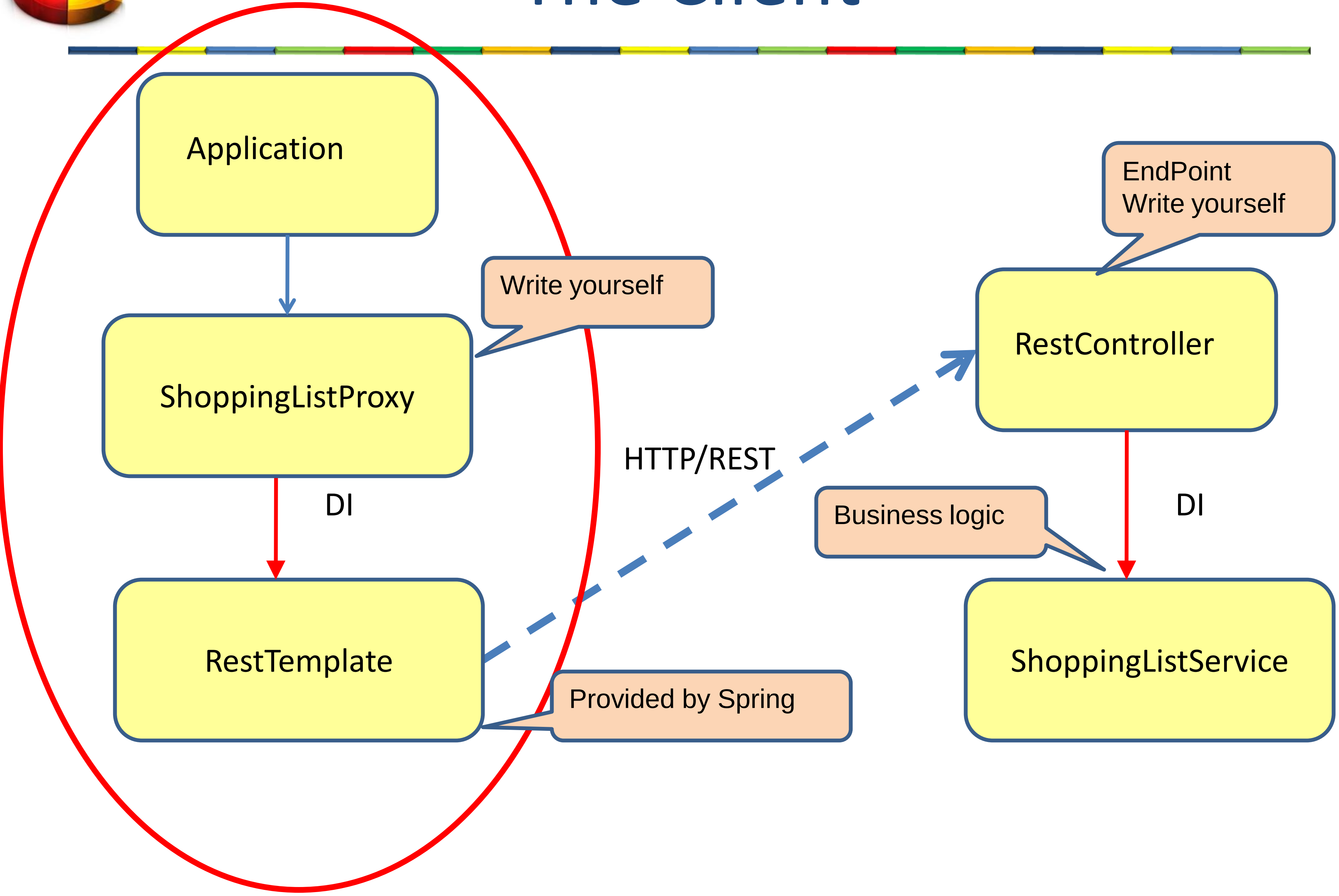
```
   <bean id="marshallingHttpMessageConverter"
       class="org.springframework.http.converter.xml.MarshallingHttpMessageConverter">
     <property name="marshaller" ref="marshaller"/>
     <property name="unmarshaller" ref="marshaller"/>
   </bean>

   <bean
    class="org.springframework.web.servlet.mvc.annotation.AnnotationMethodHandlerAdapter">
     <property name="messageConverters">
       <util:list id="beanList">
         <ref bean="marshallingHttpMessageConverter"/>
       </util:list>
     </property>
   </bean>

   <bean id="marshalview" class="org.springframework.web.servlet.view.xml.MarshallingView">
     <property name="contentType" value="text/xml"/>
     <property name="marshaller" ref="marshaller"/>
   </bean>

</beans>
```

Can Converts http messages into Objects using the marshaller

Applies http converter to incoming messages

The “marchalview” view bean is an object marshaller using JAXB

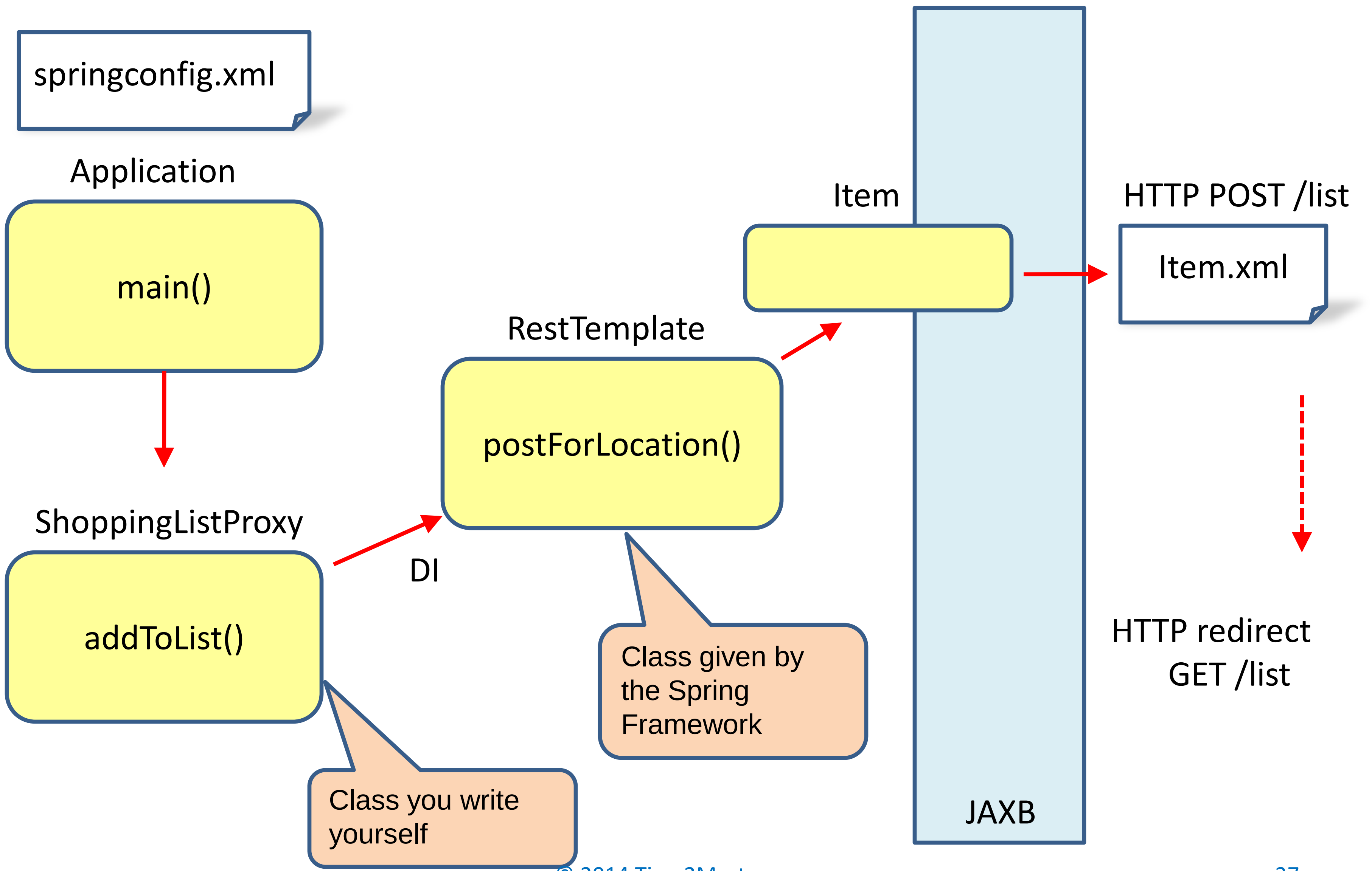
The Client


Application
ShoppingListProxy
Write yourself
DI
RestTemplate
Provided by Spring
HTTP/REST
EndPoint
Write yourself
RestController
DI
Business logic
ShoppingListService

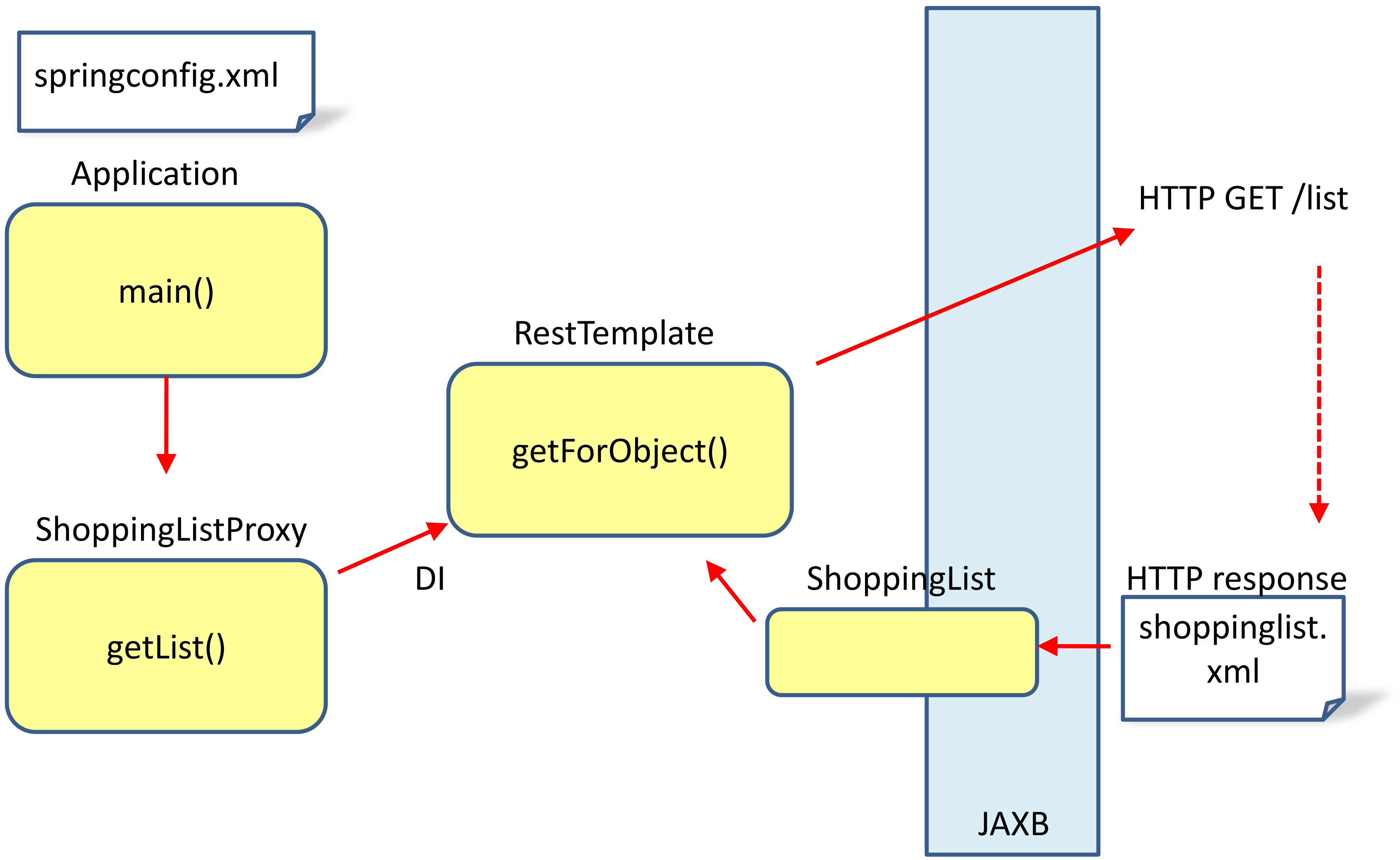
RestTemplate methods

HTTP	Method	Description
DELETE	delete()	Delete the resources at the specified URI
GET	getForObject()	Retrieve a representation by doing a GET
POST	postForLocation	Create a new resource by POSTing the given object
PUT	put	Creates or updates the resource at the given location by PUTting the given object

Client addToList()



Client getList()



REST Client

```java
public class Application {

  public static void main(String[] args) {
    ApplicationContext context = new ClassPathXmlApplicationContext("springconfig.xml");
    IShoppingListService remoteService = context.getBean("shopListProxy",
                                                          IShoppingListService.class);

    Item tomato = new Item("Tomatoes", 3, "Prefer Organic");
    Item avocado = new Item("Avocados", 3, "Organic or non-organic");
    remoteService.addToList(tomato);
    remoteService.addToList(avocado);
    System.out.println(remoteService.getList());

    tomato.setQty(5);
    remoteService.updateItem(tomato);
    System.out.println(remoteService.getList());

    remoteService.removeFromList("Avocados");
    System.out.println(remoteService.getList());
  }
}
```

Add Tomatoes and Avocados

Update Tomatoes

Remove Avocados

```
3 Avocados      Organic or non-organic
3 Tomatoes      Prefer Organic

3 Avocados      Organic or non-organic
5 Tomatoes      Prefer Organic

5 Tomatoes      Prefer Organic
```

ShopListProxy

```
public class ShopListProxy implements IShoppingListService {
  private static final String listURL = "http://localhost:8080/REST/rest/list";
  private static final String itemURL = "http://localhost:8080/REST/rest/item/{product}";

  private RestTemplate restTemplate;
  public void setRestTemplate(RestTemplate restTemplate) {
    this.restTemplate = restTemplate;
  }

  public void addToList(Item item) {
    restTemplate.postForLocation(listURL, item);
  }
  public Item getItem(String product) {
    return restTemplate.getForObject(itemURL, Item.class, product);
  }
  public ShoppingList getList() {
    return restTemplate.getForObject(listURL, ShoppingList.class);
  }
  public void removeFromList(String product) {
    restTemplate.delete(itemURL, product);
  }
  public void updateItem(Item item) {
    restTemplate.put(itemURL, item, item.getProduct());
  }

}
```

DI restTemplate

POST item to listURL

GET item from itemURL

GET list from listURL

DELETE item from itemURL

UPDATE item to itemURL

springconfig.xml

```xml
<beans ... >

  <bean id="shopListProxy" class="demo.ShopListProxy">
    <property name="restTemplate" ref="restTemplate"/>
  </bean>

  <bean id="restTemplate" class="org.springframework.web.client.RestTemplate">
    <property name="messageConverters">
      <list>
        <bean
        class="org.springframework.http.converter.xml.MarshallingHttpMessageConverter">
          <property name="marshaller" ref="marshaller"/>
          <property name="unmarshaller" ref="marshaller"/>
        </bean>
      </list>
    </property>
  </bean>

  <bean id="marshaller" class="org.springframework.oxm.jaxb.Jaxb2Marshaller">
    <property name="contextPath" value="generated"/>
  </bean>

</beans>
```

Spring Web Services:

SPRING REST WITH JSON

RESTful Web Services, JAX-RS & JSON

- REST and RESTful Web Services:
  - REST: REpresentational State Transfer – a software architectural style, defined around 2000 by Roy Fielding as part of his PhD dissertation
  - In a REST architecture, data and functionality are considered resources that can be accessed via URIs (i.e. links)
- RESTful Web Services – simple, lightweight, high-performant, scalable.
  - Resource Identification through URI
  - Resource manipulation using a fixed set of operations – get, put, post delete
  - E.g URI - http://www.webserver.com/resource/id/123/ - Resource with Id of 123

RESTful Web Services, JAX-RS & JSON

- JAX-RS
  - JAVA API for RESTful Web Services
  - Reference Implementation – Project Jersey
    - https://jersey.java.net/
  - Provides support for annotations which simplifies WS implementation
    - e.g. @RequestMapping("/resources")
  - Well supported in Spring Framework

RESTful Web Service with Spring

- Create a Resource Representation Class

```
package com.cs544.model;
public class Resource {
        private int id;
        private String content;
        public Resource (int id, String content) {
          this.id = id;
          this.content = content;
        }
        public int getId() { return id; }
        public void setId(int id) { … }
        public String getContent() { return content; }
        public void setContent(String content) { …}

}
```

RESTful Web Service with Spring

- Create a Resource Controller

```
package com.cs544.controller;
import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.RequestMapping;
…
@Controller // Note: Spring 4 supports @RESTController
 @RequestMapping(“/resource/id”)
public class ResourceController {
         @RequestMapping(value="{id}", method = RequestMethod.GET,
        produces="application/json")
        public @ResponseBody Resource getResourceById (@PathVariable int id) {

            //ResourceRepository.findResourceById(id);
            Resource res = new Resource();
             res.setId(id);
             res.setContent(“something here”);
            return res;
        }
}
```

Surfacing JSON with Spring REST

- Two options exist for doing this:

  Option 1

  If the following four conditions are met:

  i. Jackson library present in classpath
  ii. @Controller annotation on controller class
  iii. Spring config has mvc:annotation-driven enabled
  iv. Return type of Controller method is annotated with @ResponseBody

  This is the Default behavior

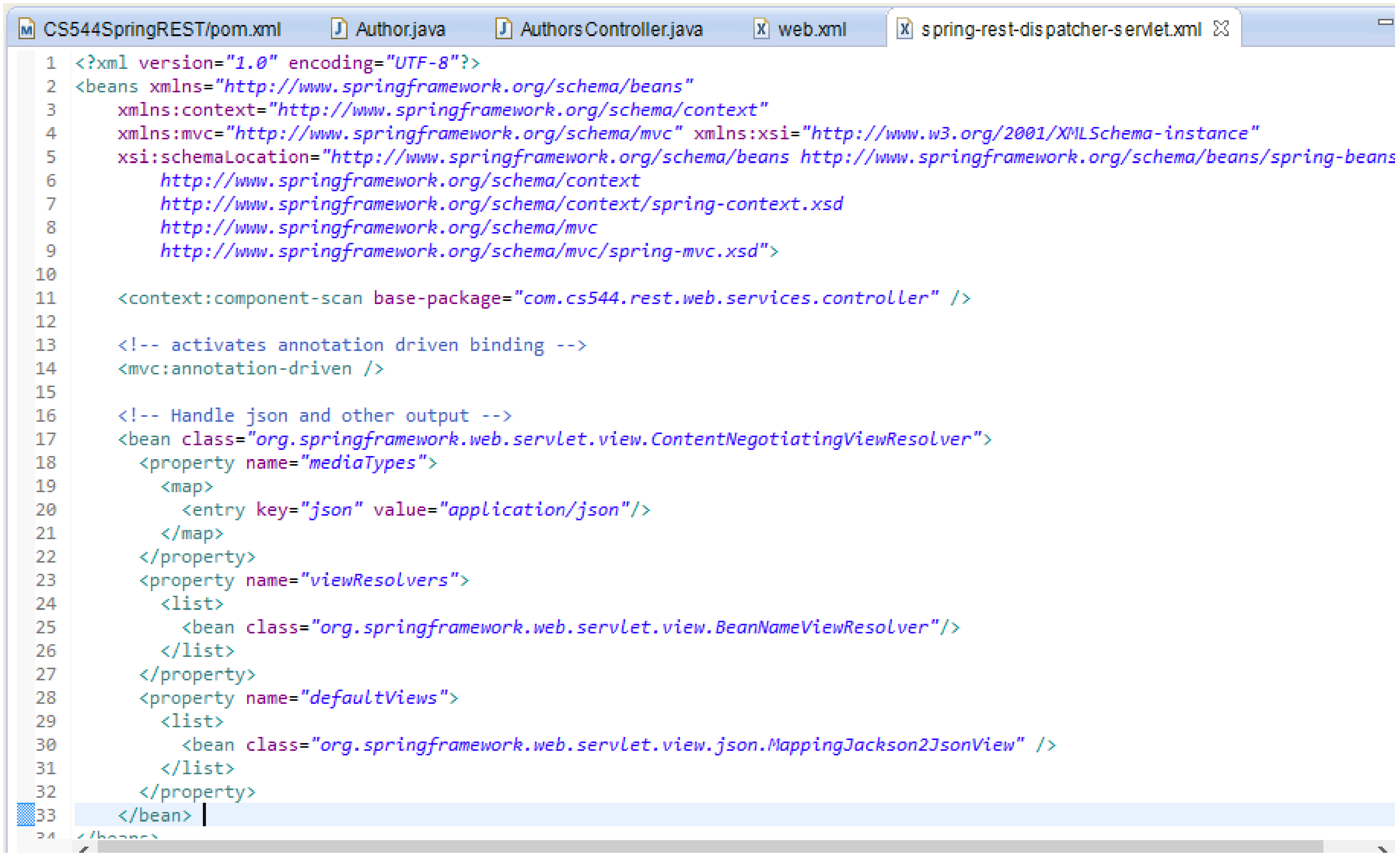
Surfacing JSON with Spring REST

- Two options exist for doing this:

Option 2

- This entails overriding the Default behavior by explicitly setting appropriate configurations in Spring-Config.xml
- Includes mainly setting appropriate bean class for handling ContentNegotiation and specifying supported mediaTypes

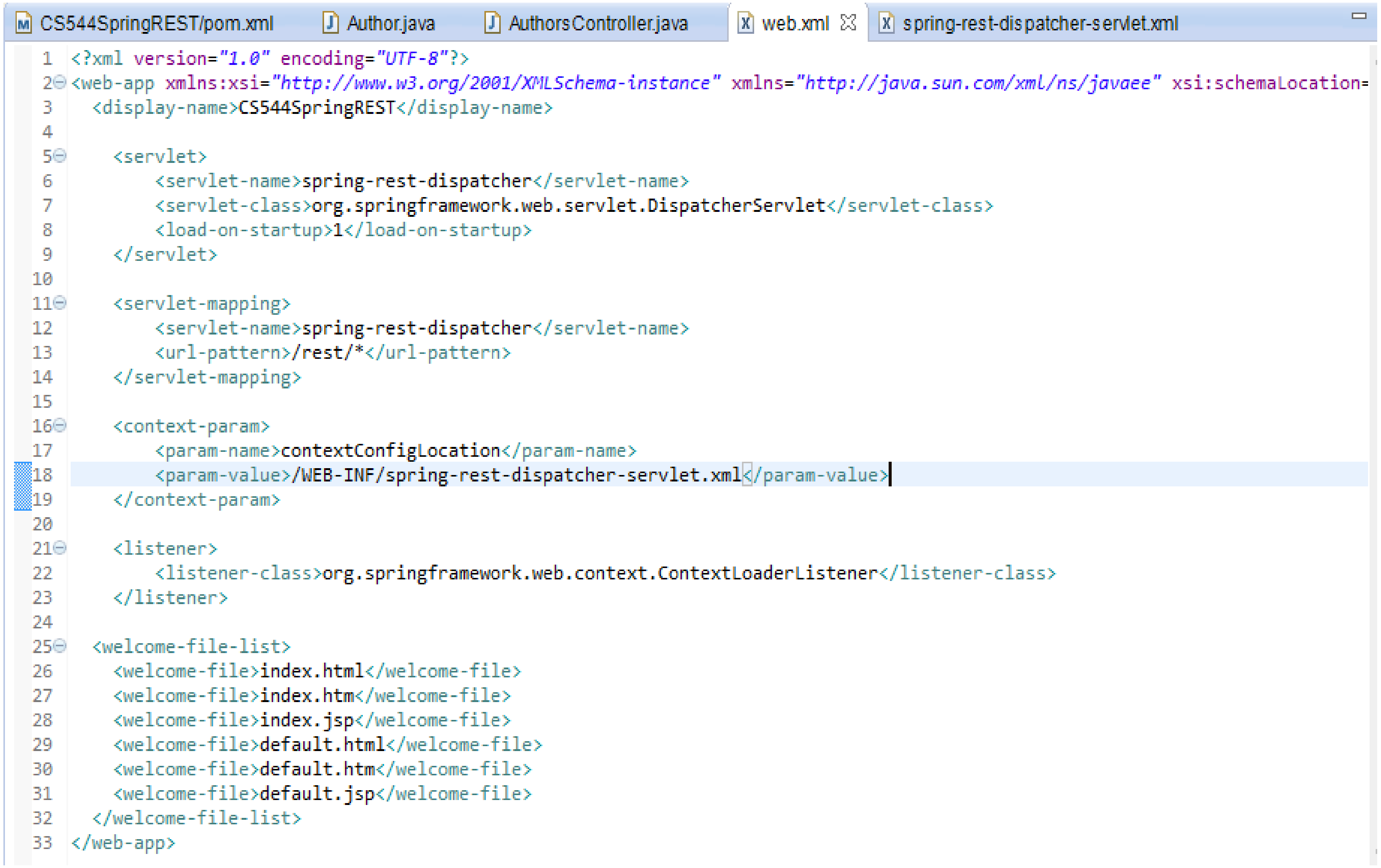
RESTful WS – Spring Config



CS544SpringREST/pom.xml | Author.java | AuthorsController.java | web.xml | spring-rest-dispatcher-servlet.xml

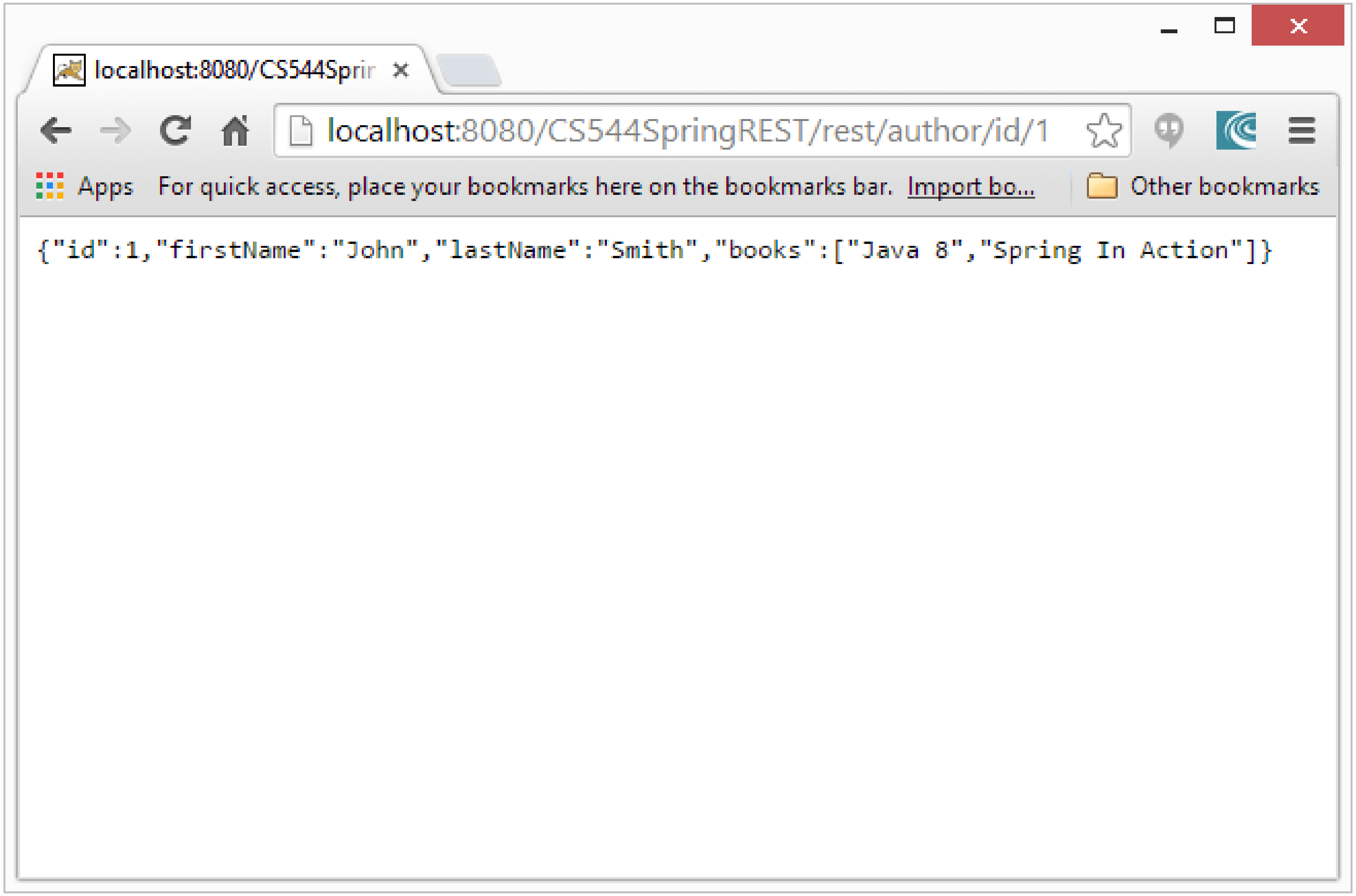
```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:context="http://www.springframework.org/schema/context"
    xmlns:mvc="http://www.springframework.org/schema/mvc" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.springframework.org/schema/beans http://www.springframework.org/schema/beans/spring-beans
        http://www.springframework.org/schema/context
        http://www.springframework.org/schema/context/spring-context.xsd
        http://www.springframework.org/schema/mvc
        http://www.springframework.org/schema/mvc/spring-mvc.xsd">

    <context:component-scan base-package="com.cs544.rest.web.services.controller" />

    <!-- activates annotation driven binding -->
    <mvc:annotation-driven />

    <!-- Handle json and other output -->
    <bean class="org.springframework.web.servlet.view.ContentNegotiatingViewResolver">
      <property name="mediaTypes">
        <map>
          <entry key="json" value="application/json"/>
        </map>
      </property>
      <property name="viewResolvers">
        <list>
          <bean class="org.springframework.web.servlet.view.BeanNameViewResolver"/>
        </list>
      </property>
      <property name="defaultViews">
        <list>
          <bean class="org.springframework.web.servlet.view.json.MappingJackson2JsonView" />
        </list>
      </property>
    </bean>
</beans>
```

RESTful WS – Spring Config



```xml
<?xml version="1.0" encoding="UTF-8"?>
<web-app xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://java.sun.com/xml/ns/javaee" xsi:schemaLocation=
  <display-name>CS544SpringREST</display-name>

    <servlet>
        <servlet-name>spring-rest-dispatcher</servlet-name>
        <servlet-class>org.springframework.web.servlet.DispatcherServlet</servlet-class>
        <load-on-startup>1</load-on-startup>
    </servlet>

    <servlet-mapping>
        <servlet-name>spring-rest-dispatcher</servlet-name>
        <url-pattern>/rest/*</url-pattern>
    </servlet-mapping>

    <context-param>
        <param-name>contextConfigLocation</param-name>
        <param-value>/WEB-INF/spring-rest-dispatcher-servlet.xml</param-value>
    </context-param>

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

  <welcome-file-list>
    <welcome-file>index.html</welcome-file>
    <welcome-file>index.htm</welcome-file>
    <welcome-file>index.jsp</welcome-file>
    <welcome-file>default.html</welcome-file>
    <welcome-file>default.htm</welcome-file>
    <welcome-file>default.jsp</welcome-file>
  </welcome-file-list>
</web-app>
```

SPRING RESTFUL WS – JSON OUTPUT


localhost:8080/CS544Sprir
localhost:8080/CS544SpringREST/rest/author/id/1
Apps
For quick access, place your bookmarks here on the bookmarks bar. Import bo...
Other bookmarks

```
{"id":1,"firstName":"John","lastName":"Smith","books":["Java 8","Spring In Action"]}
```

Main Point

- RESTful webservices are based on HTTP requests, and therefore easy to implement with Spring MVC.
- Science of Consciousness: Unity in Diversity, Spring MVC can be used for both web pages and REST web services

Spring webservices

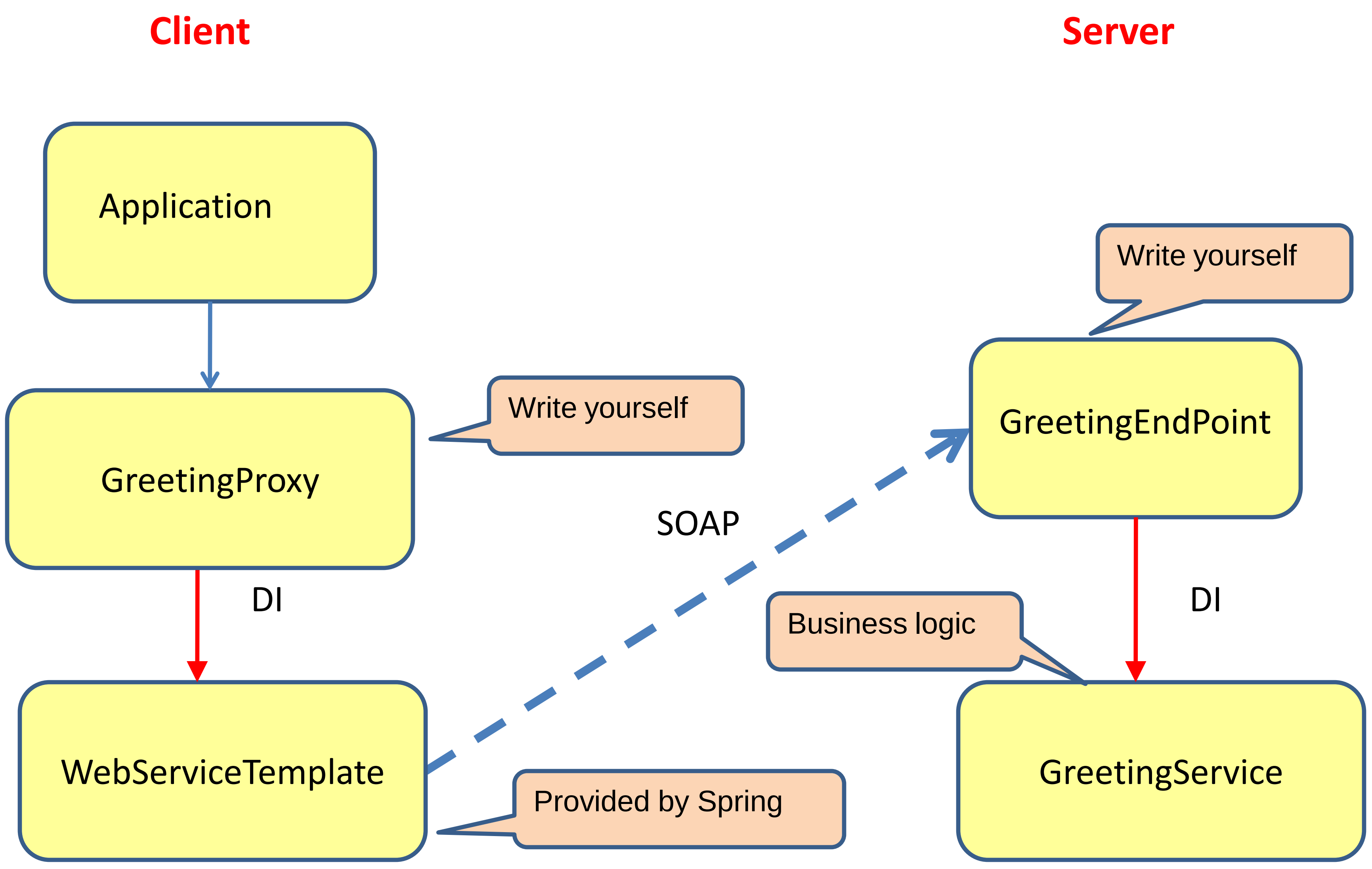
SPRING SOAP WEBSERVICES

Spring WS

- In a contract first approach we need to:
  1. Create a WSDL file for our web service
  2. Create implementation based on the WSDL

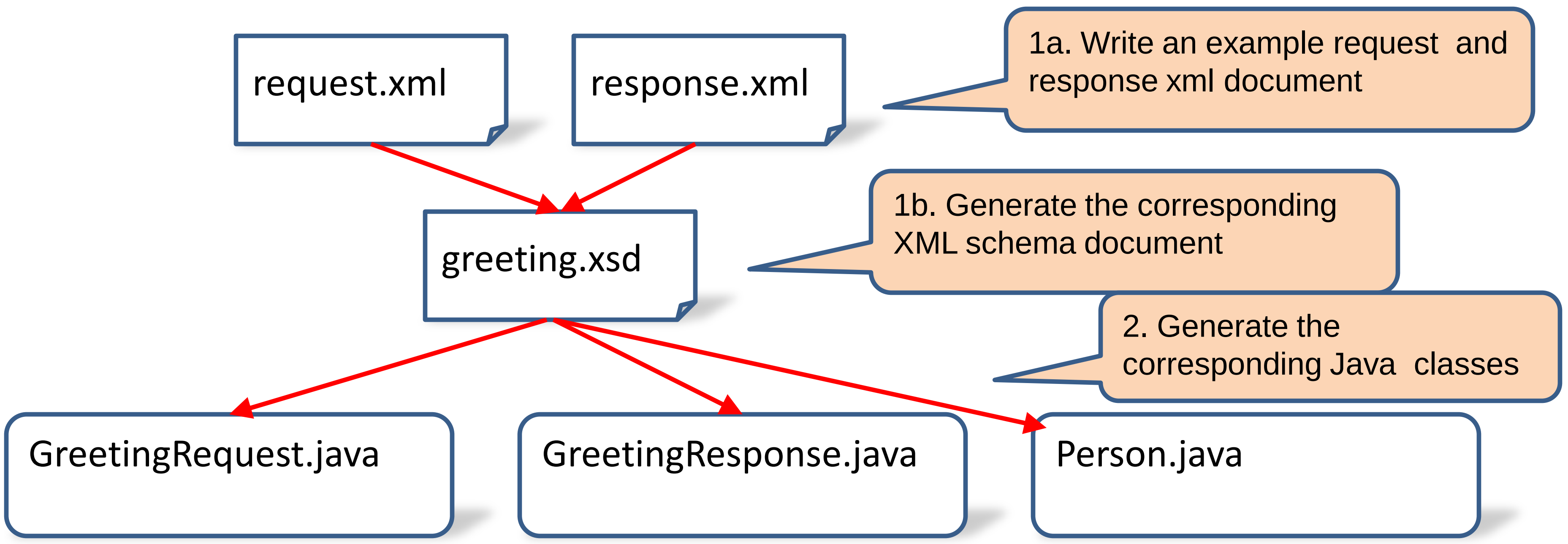
- Spring WS can automatically generate WSDL from an XML schema definition
- We can generate Java classes from an XML schema for our implementation

Spring WS



Client
Server
Application
GreetingProxy
Write yourself
DI
WebServiceTemplate
Provided by Spring
SOAP
Write yourself
GreetingEndPoint
DI
Business logic
GreetingService

Creating a Spring-WS server



1a. Write an example request and response xml document

1b. Generate the corresponding XML schema document

2. Generate the corresponding Java classes

```
@Endpoint
public class GreetingEndpoint {

  private IGreeting greetingService;
```

```
public class GreetingService
    implements IGreeting {
```

web.xml

greeting-servlet..xml

3. Write the EndPoint, the Service implementation, web.xml and the Spring configuration file

Step 1a: Schema Creation

- The easiest way to create an XML schema is to infer it from sample documents.
- We have two sample documents
  1. The XML message that we sent to web service

```xml
<?xml version="1.0" encoding="UTF-8"?>
<GreetingRequest xmlns="http://springtraining/greeting">
  <Person>
    <FirstName>John</FirstName>
    <LastName>Doe</LastName>
  </Person>
</GreetingRequest>
```

  2. The XML message that the web service returns

```xml
<?xml version="1.0" encoding="UTF-8"?>
<GreetingResponse  xmlns="http://springtraining/greeting">
  <Greeting>Hello John Doe!</Greeting>
</GreetingResponse>
```

Step 1b: Greeting.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema attributeFormDefault="unqualified" elementFormDefault="qualified"
  targetNamespace="http://springtraining/greeting"
  xmlns:xs="http://www.w3.org/2001/XMLSchema">

  <xs:element name="GreetingRequest">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="Person">
          <xs:complexType>
            <xs:all>
              <xs:element type="xs:string" name="FirstName" />
              <xs:element type="xs:string" name="LastName" />
            </xs:all>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>

  <xs:element name="GreetingResponse">
    <xs:complexType>
      <xs:sequence>
        <xs:element type="xs:string" name="Greeting" />
      </xs:sequence>
    </xs:complexType>
  </xs:element>

</xs:schema>
```

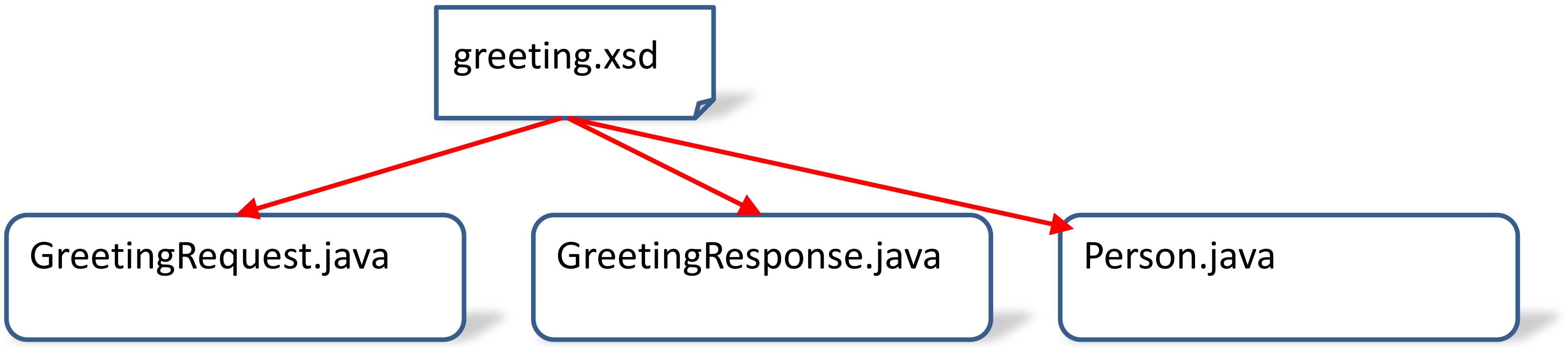
Request message schema

Contained elements may be in any sequence

Response message schema

Step 2: Generated Code

- We can generate Java classes based on this schema definition.
  - The generated classes will have Java Architecture for XML Binding (JAXB) annotations
  - JAXB is an Object/XML (O/X) mapping framework
  - O/X mapping frameworks automate the conversion of Objects to and from XML



GreetingRequest

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "", propOrder = {"person"})
@XmlRootElement(name = "GreetingRequest")
public class GreetingRequest {

    @XmlElement(name = "Person", required = true)
    protected Person person;

    public Person getPerson() {
        return person;
    }

    public void setPerson(Person value) {
        this.person = value;
    }
}
```

Class JAXB annotations

Attribute JAXB annotations

Single person attribute

$$\begin{tikzcd}\text{greeting.xsd} \arrow[d] \\ \text{GreetingRequest.java}\end{tikzcd}$$

Person

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "", propOrder = {})
public class Person {
    @XmlElement(name = "FirstName", required = true)
    protected String firstName;
    @XmlElement(name = "LastName", required = true)
    protected String lastName;

    public String getFirstName() {
        return firstName;
    }
    public void setFirstName(String value) {
        this.firstName = value;
    }
    public String getLastName() {
        return lastName;
    }
    public void setLastName(String value) {
        this.lastName = value;
    }
}
```

JAXB class annotations

firstName and lastName attributes with JAXB annotations

Very similar to our previous Person class

$$\begin{tikzcd}\boxed{\text{greeting.xsd}} \arrow[r] & \boxed{\text{Person.java}}\end{tikzcd}$$

GreetingResponse

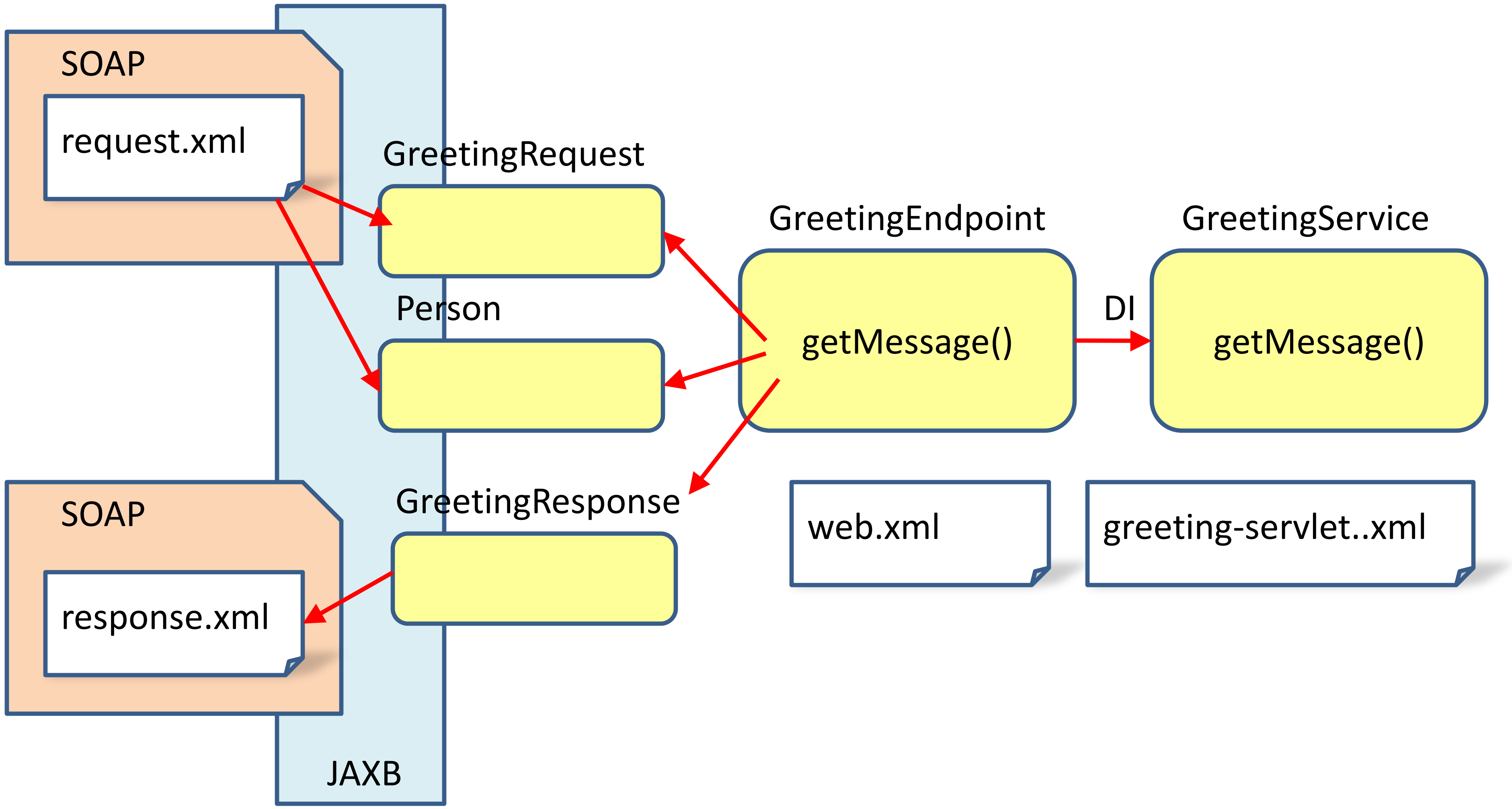
```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "", propOrder = {"greeting"})
@XmlRootElement(name = "GreetingResponse")
public class GreetingResponse {

    @XmlElement(name = "Greeting", required = true)
    protected String greeting;

    public String getGreeting() {
        return greeting;
    }

    public void setGreeting(String value) {
        this.greeting = value;
    }
}
```

GreetingResponse class with generated JAXB

Response greeting String

$$\begin{tikzcd}\text{greeting.xsd} \arrow[d] \\ \text{GreetingResponse.java}\end{tikzcd}$$

Step 3: writing the Webservice implementation



GreetingEndpoint Implementation

```
@Endpoint
public class GreetingEndpoint {

  private IGreeting greetingService;

  public GreetingEndpoint(IGreeting greetingService) {
    this.greetingService = greetingService;
  }

  @PayloadRoot(localPart = "GreetingRequest", namespace =
      "http://springtraining/greeting")
  public GreetingResponse getMessage(GreetingRequest request) {
    GreetingResponse response = new GreetingResponse();
    response.setGreeting(greetingService.getMessage(request.getPerson()));
    return response;
  }
}
```

@Endpoint

Normal POJO

DI greetingService

@PayloodRoot, specifies this method as a web service endpoint

Business logic is delegated, method itself just handles request / response

GreetingService

```java
package demo;

public class GreetingService implements IGreeting {
  private String greeting;

  public void setGreeting(String greeting) {
    this.greeting = greeting;
  }

  public String getMessage(Person person) {
    return greeting + " " + person.getFirstName() + " " + person.getLastName();
  }
}
```

Same GreetingService as in previous examples

Dependency Injected greeting string

web.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<web-app xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="http://java.sun.com/xml/ns/javaee"
  xmlns:web="http://java.sun.com/xml/ns/javaee/web-app_2_5.xsd"
  xsi:schemaLocation="http://java.sun.com/xml/ns/javaee
  http://java.sun.com/xml/ns/javaee/web-app_2_5.xsd"
  id="WebApp_ID" version="2.5">

  <display-name>module13Example-SpringWS</display-name>

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

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

</web-app>
```

Spring Message Dispatcher Servlet

Mapped to all incoming requests

greeting-servlet.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:aop="http://www.springframework.org/schema/aop"
xmlns:tx="http://www.springframework.org/schema/tx"
xsi:schemaLocation="
       http://www.springframework.org/schema/beans
       http://www.springframework.org/schema/beans/spring-beans-2.5.xsd
       http://www.springframework.org/schema/tx
       http://www.springframework.org/schema/tx/spring-tx-3.0.xsd
       http://www.springframework.org/schema/aop
       http://www.springframework.org/schema/aop/spring-aop-3.0.xsd">

  <bean id="greetingEndpoint" class="demo.GreetingEndpoint">
    <constructor-arg ref="greetingService"/>
  </bean>

  <bean id="greetingService" class="demo.GreetingService" >
    <property name="greeting" value="Hello"/>
  </bean>

...
```

greetingEndpoint uses DI for greetingService

greetingService bean with DI greeting string

greeting-servlet.xml continued

```
 <bean id="messageFactory" class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory">
    <property name="messageFactory">
      <bean class="com.sun.xml.messaging.saaj.soap.ver1_1.SOAPMessageFactory1_1Impl" />
    </property>
  </bean>

  <bean
class="org.springframework.ws.server.endpoint.mapping.PayloadRootAnnotationMethodEndpointMapping"
  />

  <bean
class="org.springframework.ws.server.endpoint.adapter.GenericMarshallingMethodEndpointAdapter">
    <constructor-arg ref="marshaller"/>
  </bean>
  <bean id="marshaller" class="org.springframework.oxm.jaxb.Jaxb2Marshaller">
    <property name="contextPath" value="generated"/>
  </bean>

  <bean id="greeting" class="org.springframework.ws.wsdl.wsdl11.DefaultWsdl11Definition">
    <property name="schema" value="schema" />
    <property name="portTypeName" value="Greeting" />
    <property name="locationUri" value="/greeting" />
    <property name="targetNamespace" value="http://springtraining/greeting" />
  </bean>

  <bean id="schema" class="org.springframework.xml.xsd.SimpleXsdSchema">
    <property name="xsd" value="/WEB-INF/greeting.xsd" />
  </bean>

</beans>
```

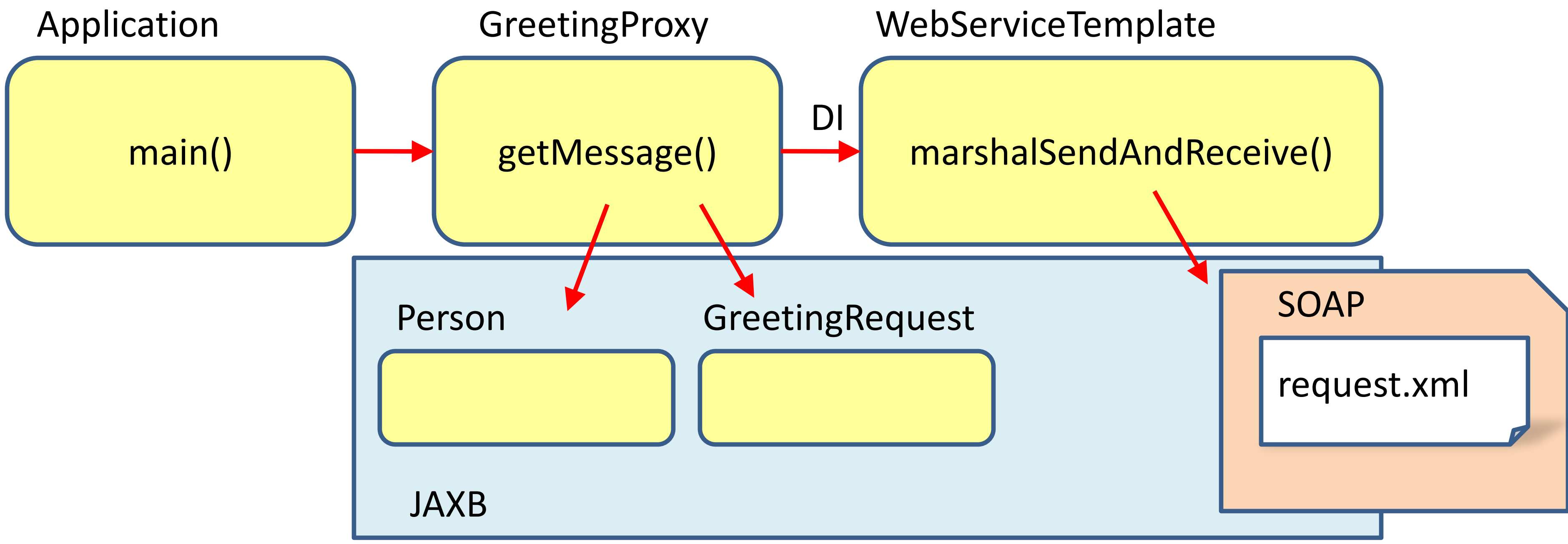
messageFactory for sending and receving XML messages

Indicates annotated endpoints

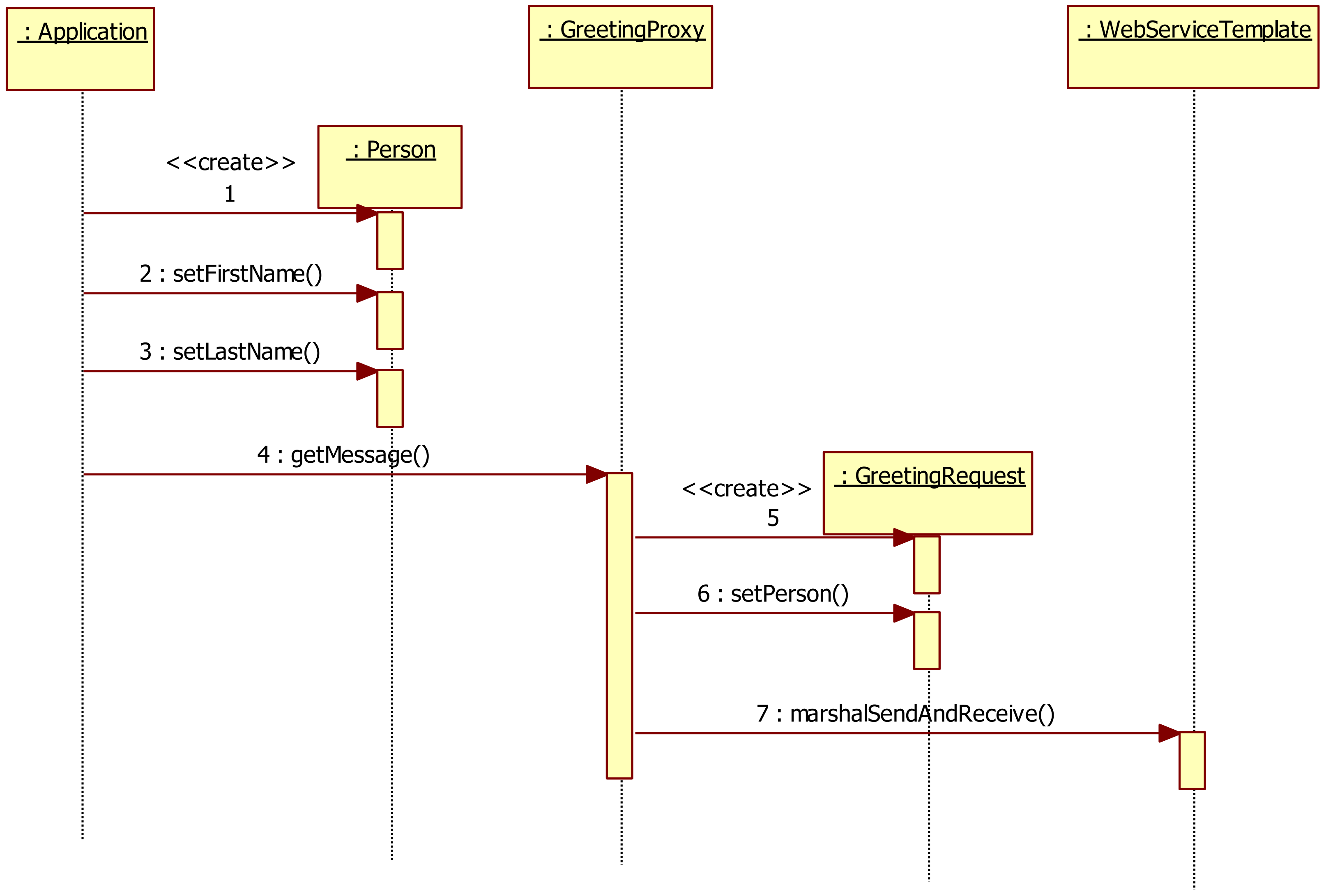
Configures O/X Mapping

WSDL Generation from schema

Spring-WS client



Spring-WS client



Spring WS Client

```
public class Application {

  public static void main(String[] args) {
    ApplicationContext context = new ClassPathXmlApplicationContext("springconfig.xml");
    IGreeting remoteService = context.getBean("greetingServiceProxy", IGreeting.class);

    Person person = new Person();
    person.setFirstName("John");
    person.setLastName("Doe");
    String result = remoteService.getMessage(person);
    System.out.println("Receiving result: " + result);
  }
}
```

Create Person

Get message

```
Receiving result: Hello John Doe
```

GreetingServiceProxy

```
public class GreetingServiceProxy implements IGreeting {

  private WebServiceTemplate webServiceTemplate;

  public void setWebServiceTemplate(WebServiceTemplate webServiceTemplate) {
    this.webServiceTemplate = webServiceTemplate;
  }

  public String getMessage(Person person) {
    GreetingRequest request = new GreetingRequest();
    request.setPerson(person);

    GreetingResponse response =(GreetingResponse)
        webServiceTemplate.marshalSendAndReceive(request);
    return response.getGreeting();
  }
}
```

Implements IGreeting

DI Web Service Template

Sends Request, receives Response object

springconfig.xml

```
<beans xmlns="... ">

  <bean id="greetingServiceProxy" class="demo.GreetingServiceProxy">
    <property name="webServiceTemplate" ref="webServiceTemplate" />
  </bean>

  <bean id="webServiceTemplate" class="org.springframework.ws.client.core.WebServiceTemplate">
    <constructor-arg ref="messageFactory" />
    <property name="defaultUri" value="http://localhost:8080/SpringWS" />
    <property name="marshaller" ref="marshaller"/>
    <property name="unmarshaller" ref="marshaller"/>
  </bean>

  <bean id="marshaller" class="org.springframework.oxm.jaxb.Jaxb2Marshaller">
    <property name="contextPath" value="generated"/>
  </bean>

  <bean id="messageFactory" class="org.springframework.ws.soap.saaj.SaajSoapMessageFactory">
    <property name="messageFactory">
      <bean class="com.sun.xml.messaging.saaj.soap.ver1_1.SOAPMessageFactory1_1Impl" />
    </property>
  </bean>

</beans>
```

GreetingProxy bean using webServiceTemplate

webServiceTemplate has the URI of our web service

Jaxb2 O/X marshalling

messageFactory for sending / receiving messages

Endpoint Implementations

- We used an O/X framework in our example
- Spring also provides many Endpoint templates that help you parse the XML on your own:
  - AbstractDomPayloadEndpoint
  - AbstractJDomPayloadEndpoint
  - AbstractDom4jPayloadEndpoint
  - AbstractSaxPayloadEndpoint
  - AbstractXomPayloadEndpoint

Main Point

- SOAP Web services always use XML data, but can theoretically use any transport protocol. More Enterprise like additions such as Security and Transactions are also standardized.
- Science of Consciousness: The whole is greater than the sum of the parts, web services bring together many parts to make a bigger whole

Spring Web Services:

SPRING HTTP INVOKER

Spring HTTP Invoker

- The Spring HTTP Invoker provides a simple and efficient way to implement Java-to-Java web services
- Objects are simply serialized and sent back and forth over HTTP
- The advantages are that it is faster to implement and faster to transmit
- The disadvantage is that it is only possible if both sides are Java applications

Java Implementation

```
public interface IGreeting {
  public String getMessage(Person person);
}
```

IGreeting interface, GreetingService and Person class exactly as we've used them before.

```
public class GreetingService implements IGreeting {
  private String greeting;

  public void setGreeting(String greeting) {
    this.greeting = greeting;
  }

  public String getMessage(Person person) {
    return greeting + " " + person.getFirstName() + " " + person.getLastName();
  }
}
```

```
public class Person implements Serializable {
  private static final long serialVersionUID = 1L;
  private String firstName;
  private String lastName;

  public Person() {
  }
  public Person(String firstName, String lastName) {
    this.firstName = firstName;
    this.lastName = lastName;
  }
  ...
```

web.xml

```
<web-app version="2.4"
    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">

  <servlet>
    <servlet-name>greeting</servlet-name>
    <servlet-class>org.springframework.web.servlet.DispatcherServlet</servlet-class>
    <load-on-startup>1</load-on-startup>
  </servlet>

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

</web-app>
```

Spring Dispatcher Servlet

All URLs Servlet Mapping

greeting-servlet.xml

```xml
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:aop="http://www.springframework.org/schema/aop"
  xmlns:tx="http://www.springframework.org/schema/tx"
  xsi:schemaLocation="
       http://www.springframework.org/schema/beans
       http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
       http://www.springframework.org/schema/tx
       http://www.springframework.org/schema/tx/spring-tx-3.0.xsd
       http://www.springframework.org/schema/aop
       http://www.springframework.org/schema/aop/

  <bean id="greetingService" class="httpInvoker.GreetingService">
    <property name="greeting" value="Hello" />
  </bean>

  <bean name="/GreetingService"
        class="org.springframework.remoting.httpinvoker.HttpInvokerServiceExporter">
    <property name="service" ref="greetingService" />
    <property name="serviceInterface" value="httpInvoker.IGreeting" />
  </bean>

</beans>
```

Regular Bean with DI greeting

URL mapping

HttpInvokerServiceExporter

Sets service provider

Service Interface

HttpInvoker Client

```
public class Application {

  public static void main(String[] args) {
    ApplicationContext context = new ClassPathXmlApplicationContext("springconfig.xml");
    IGreeting remoteService = context.getBean("greetingHttpInvokerProxy", IGreeting.class);

    Person person = new Person("John", "Doe");
    String result = remoteService.getMessage(person);
    System.out.println("Receiving result: " + result);
  }
}
```

Get Remote Service

Preform getMessage Call

Print Result

```
Receiving result: Hello John Doe
```

springconfig.xml

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:aop="http://www.springframework.org/schema/aop"
  xmlns:tx="http://www.springframework.org/schema/tx"
  xsi:schemaLocation="
       http://www.springframework.org/schema/beans
       http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
       http://www.springframework.org/schema/tx
       http://www.springframework.org/schema/tx/spring-tx-3.0.xsd
       http://www.springframework.org/schema/aop
       http://www.springframework.org/schema/aop/spring-aop-3.0.xsd">

  <bean id="greetingHttpInvokerProxy"
      class="org.springframework.remoting.httpinvoker.HttpInvokerProxyFactoryBean">
    <property name="serviceUrl" value="http://localhost:8080/HttpInvoker/GreetingService" />
    <property name="serviceInterface" value="httpInvoker.IGreeting" />
  </bean>

</beans>
```

Main Point

- Spring HTTP Invoker allows you to quickly connect different Spring applications over the web, using serialized Java objects that are sent back and forth
- Science of Consciousness: Do less and Accomplish more, if both sides are Spring it's quick and easy to have them communicate over the web with HTTPInvoker

Active Learning

- Describe the difference between the POST and the PUT method
- Describe the differences between SOAP and REST

Summary

- There are different ways to implement a web service server and client with Spring
  - Integrate Spring with Axis2 (SOAP)
  - Integrate Spring with CXF (SOAP)
  - Using Spring-WS (SOAP)
  - Using Spring REST (REST)
  - Using the Spring HttpInvoker (Serialized object over HTTP)
- Spring hides most of the webservice implementation details.