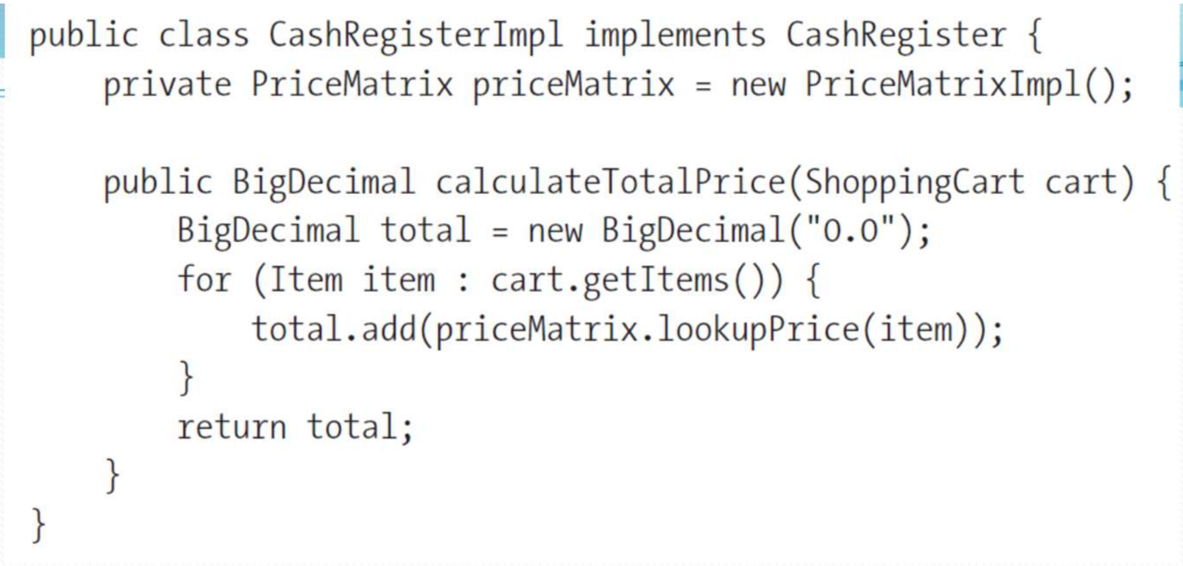
```java
public interface PriceMatrix {
    public BigDecimal lookupPrice(Item item);
}
```

```java
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix = new PriceMatrixImpl();

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

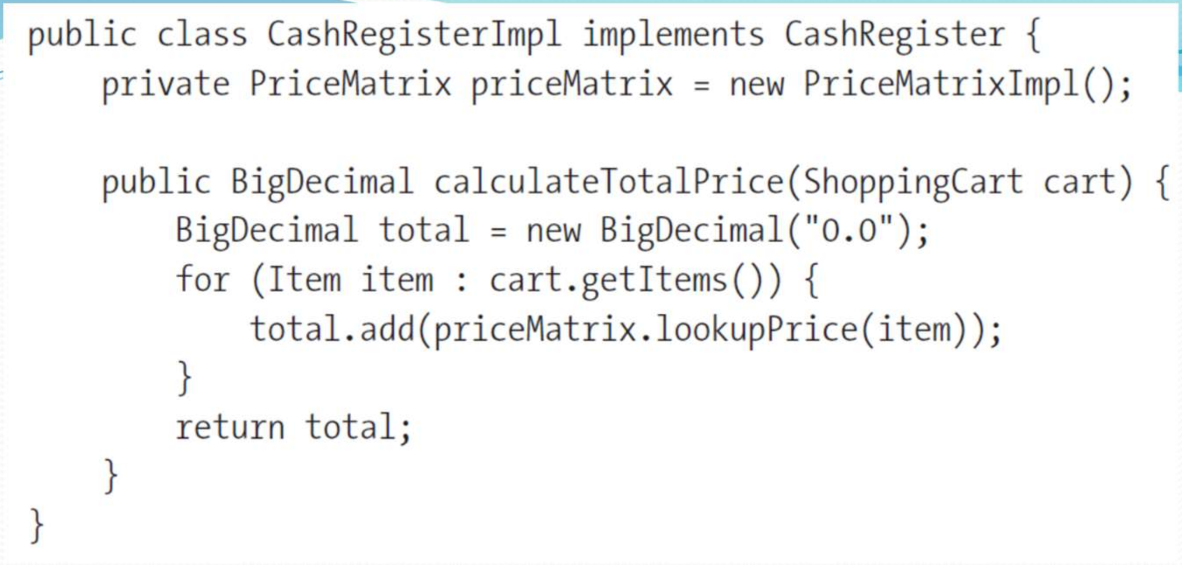
Problems



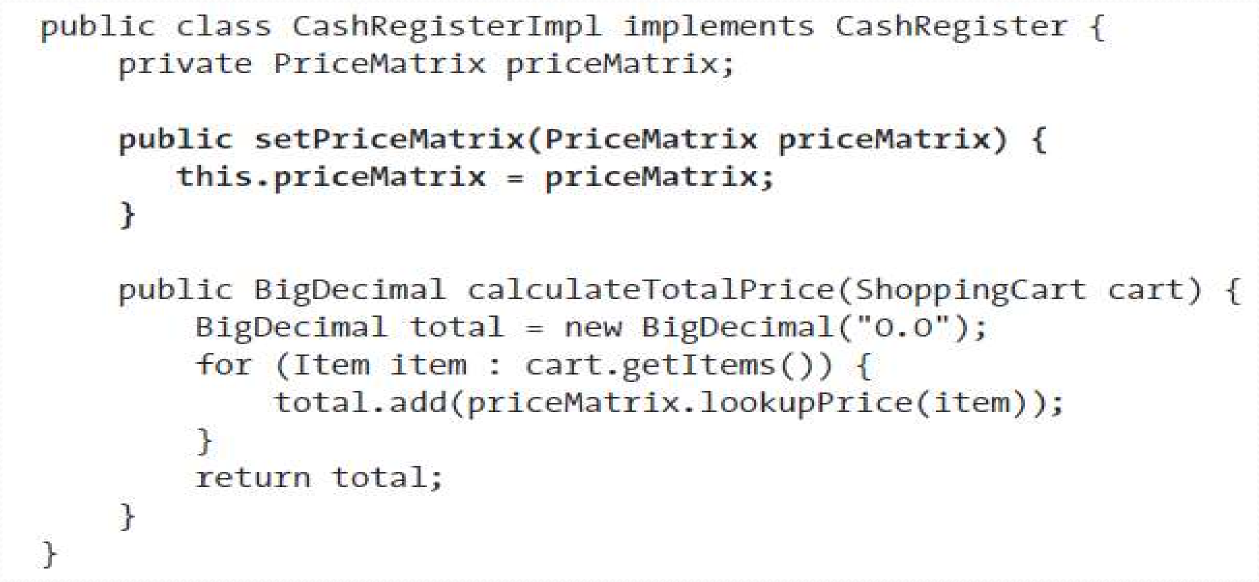
```
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix = new PriceMatrixImpl();

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

- Every instance of CashRegisterImpl has a separate instance of PriceMatrixImpl
  - With heavy services (those that are remote or those that require connections to external resources such as databases) it is preferable to share a single instance across multiple clients
- The CashRegisterImpl now has concrete knowledge of the implementation of PriceMatrix
  - CashRegisterImpl has tightly coupled itself to the concrete implementation class
- One of the most important tenets of writing unit tests is to divorce them from any environment requirements
- The unit test itself should run without connecting to outside resources

Don’t ask for the resource; I’ll give it to you



```
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix = new PriceMatrixImpl();

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```



```
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix;

    public setPriceMatrix(PriceMatrix priceMatrix) {
       this.priceMatrix = priceMatrix;
    }

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

Dependency Injection

- Dependency Injection is a technique to wire an application together without any participation by the code that requires the dependency.
- The client usually exposes setter methods so that the framework may inject any needed dependencies.
- By moving the dependency out of the client object, it is no longer solely owned by CashRegisterImpl, and can now easily be shared among all classes.
- The client also becomes much more testable.
- The client has no environment-specific code to tie it to a particular framework.
- DispatcherServlets route to Controllers and controllers depend on certain objects

What is Dependency Injection?

- The ability to supply (inject) an external dependency into a software component.

- Types of Dependency Injection:
  - Constructor (Most popular)
  - Setter
  - Method
  - setSortAlogorithm(SortAlgorithm sa) {
  -     this.sa=sa;
  - }

DI Example

- The IoC container is in charge of creating objects, connecting them, configuring them and managing their entire life cycle from creation to destruction
- Spring Container uses DI to manage the components that make the application.
- These objects are named *Spring beans*.
- In Spring, the objects that form the backbone of your application and that are managed by the Spring IoC container are called beans. A bean is an object that is instantiated, assembled, and otherwise managed by a Spring IoC container.
- Spring IoC Container defines the rules by which beans work.
- Bean is pre-initialized through its dependencies.
- After that, bean enters the state of readiness to perform its own functions.
- Finally, the IoC Container destroys bean

Bojkić, M., Pržulj, Đ., Stefanović, M., & Ristić, S. Usage of Dependency Injection within different frameworks.
19th International Symposium INFOTEH-JAHORINA, 18-20 March 2020

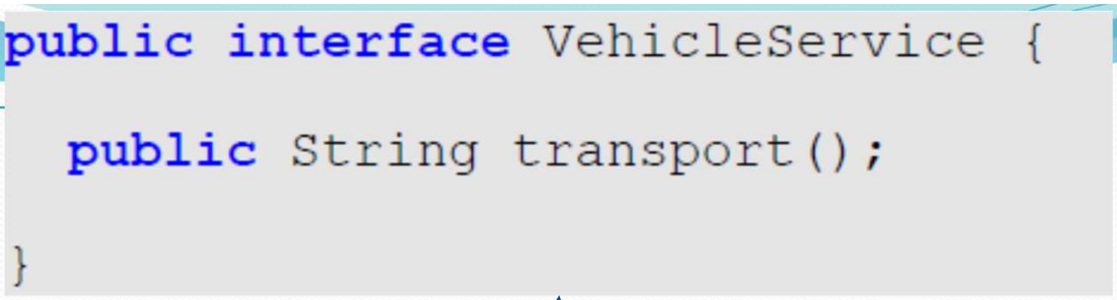
DI in Spring

- Beans are defined to be deployed in one of two modes:
  - singleton or
  - non-singleton.
- When a bean is a singleton, which is a default mode for bean’s deployment, only one shared instance of the bean will be managed
  - all requests for beans with an id or ids matching that bean definition will result in that one specific bean instance being returned.
- The non-singleton, prototype mode of a bean deployment, results in the creation of a new bean instance every time a request for that specific bean occurs.

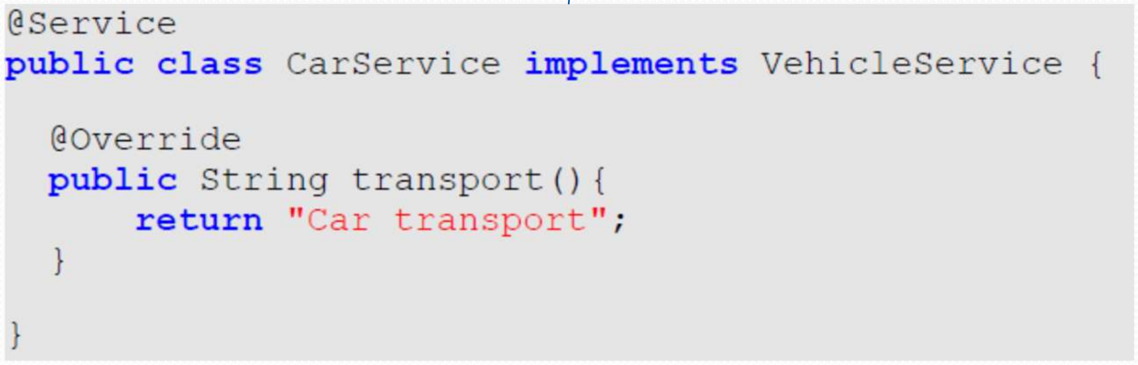
DI example

- Within a Controller

- `@Autowired`
- `CarService service;`



```java
public interface VehicleService {

  public String transport();

}
```



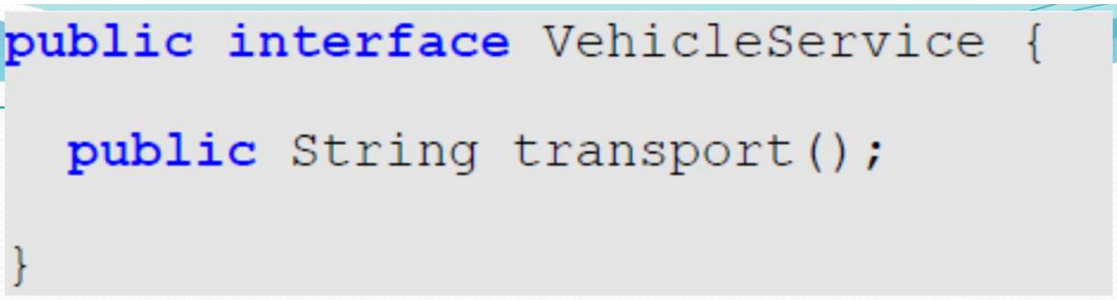
```java
@Service
public class CarService implements VehicleService {

  @Override
  public String transport(){
      return "Car transport";
  }

}
```

Managing Beans

Spring IoC container does the following

- to create a bean of *CarService*
- Assign the bean to the controller and add it to the *service* property

- To make an instance of any class that should be managed by Spring, it is necessary to add the annotation *@Component* over this particular class.
- This way Spring can manage this dependence, which means that Spring detects this as a bean, or an object managed by the Spring IoC Container.
- Spring *@Service* annotation is a specialization of *@Component* annotation. It is used to mark the class as a service provider
- The *@autowired* annotation is injecting *CarService* object into the property named *service*.

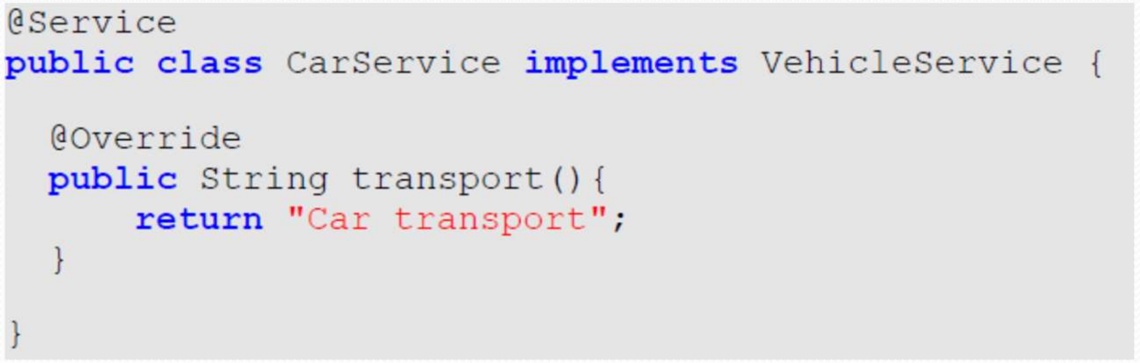


```java
public interface VehicleService {

  public String transport();

}
```

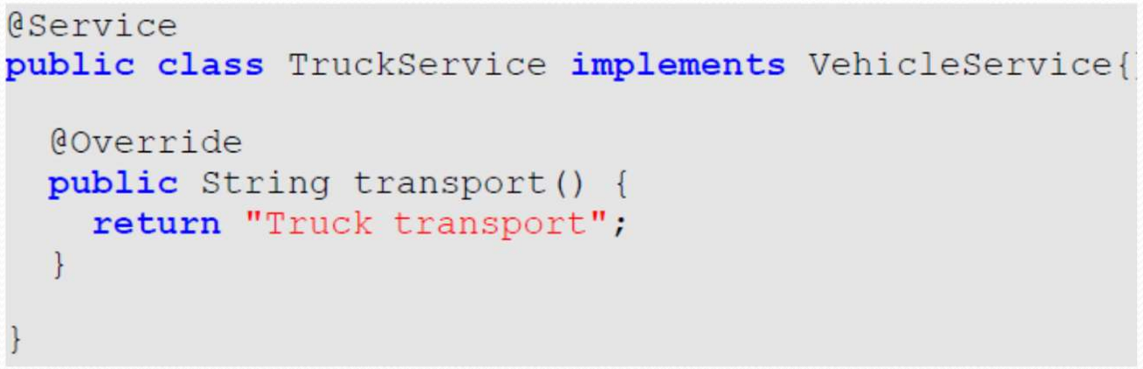
- Within a Controller

- `@Autowired`
- `VehicleService service;`

- When loaded, Spring will start looking for implementations of this interface, and since *CarService* class implements *VehicleService* interface, Spring will find this implementation and it will inject instance of appropriate class.



```java
@Service
public class CarService implements VehicleService {

  @Override
  public String transport(){
      return "Car transport";
  }

}
```



```java
@Service
public class TruckService implements VehicleService{

  @Override
  public String transport() {
    return "Truck transport";
  }

}
```

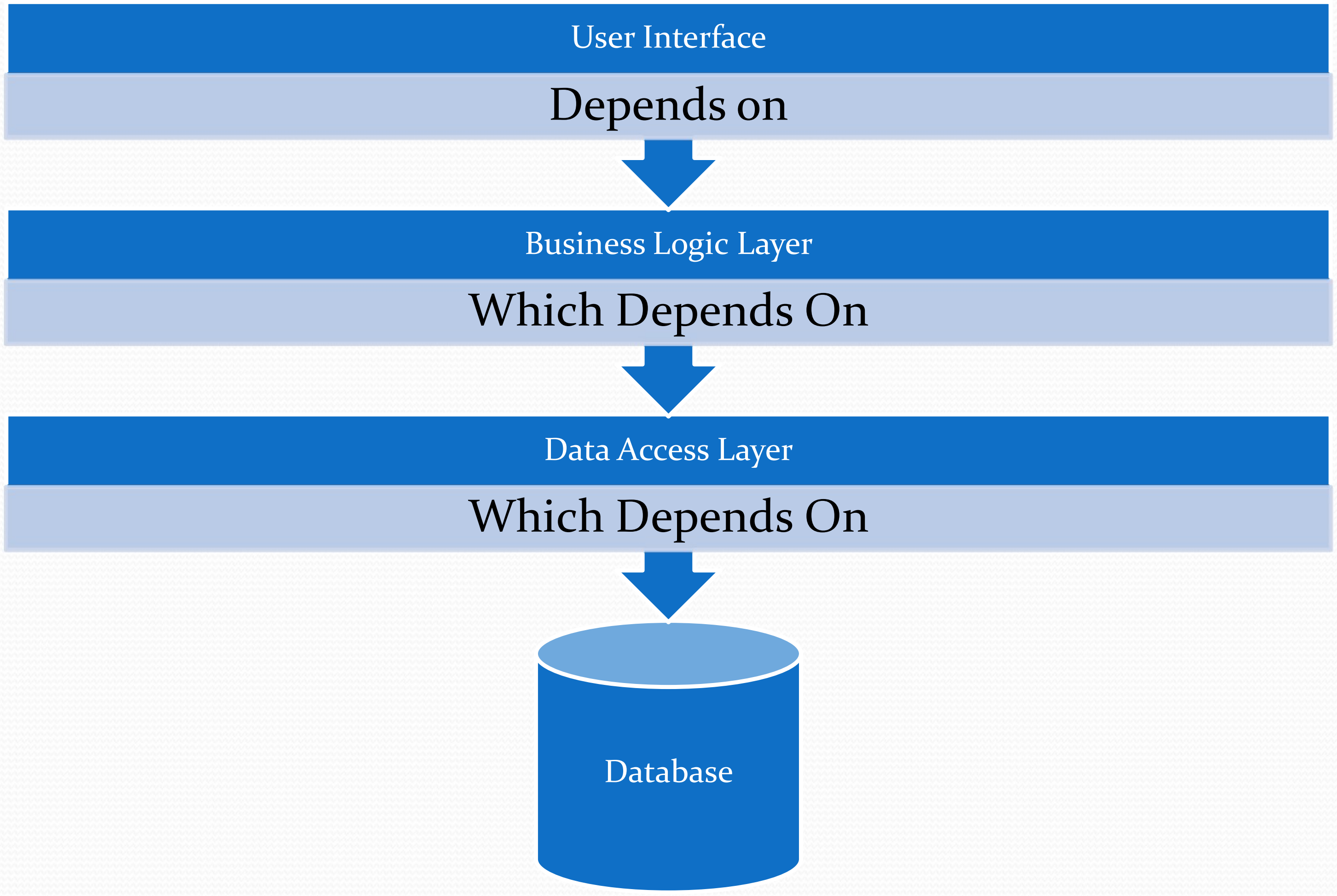
Linking services

- First approach would be renaming a particular property, named *service* to the name of the concrete service, *carService*
  - `@Autowired`
  - `VehicleService carservice;`
  - Spring detects that the name of the instance is *carService*, and that it is an implementation of *VehicleService*, so Spring is able to inject it
- Another approach in resolving this issue is adding *@Qualifier* annotation and passing the name of the bean that needs to be injected
  - `@Qualifier(value = "truckService")`
- DI can also be implemented through both constructor and set methods
- Performance cost of wiring beans is usually located in the start-up phase of application

What is a “Dependency”?

- Some common dependencies include:
  - Application Layers
    - Data Access Layer & Databases
    - Business Layer
  - External services & Components
    - Web Services
    - Third Party Components

Dependencies at a Very High Level



Dependency Injection Pros & Cons

- Pros
  - Loosely Coupled
  - Increases Testability
  - Separates components cleanly
  - Allows for use of Inversion of Control Container
- Cons
  - Increases code complexity
  - Developers learning time increases
  - Can Complicate Debugging at First
  - Complicates following Code Flow

Application Startup

- An application where configuration is stated
- Controllers
- POJOs
- Views

```
@SpringBootApplication
public class ServingWebContentApplication {

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

}
```

Spring is going to look at our application and the configuration that we're expressing in it, and then automatically, in this case, create a web container put a dispatcher servlet in that web container, and then auto discover all of our controllers in our application

`@SpringBootApplication`

- `@EnableAutoConfiguration`: enable Spring Boot's auto-configuration mechanism
- `@ComponentScan`: enable `@Component` scan on the package where the application is located
- `@Configuration`: allow to register beans in the context or import additional configuration classes

Spring Boot adds @EnableWebMvc automatically when it sees spring-webmvc on the classpath. This flags the application as a web application and activates key behaviors such as setting up a DispatcherServlet.

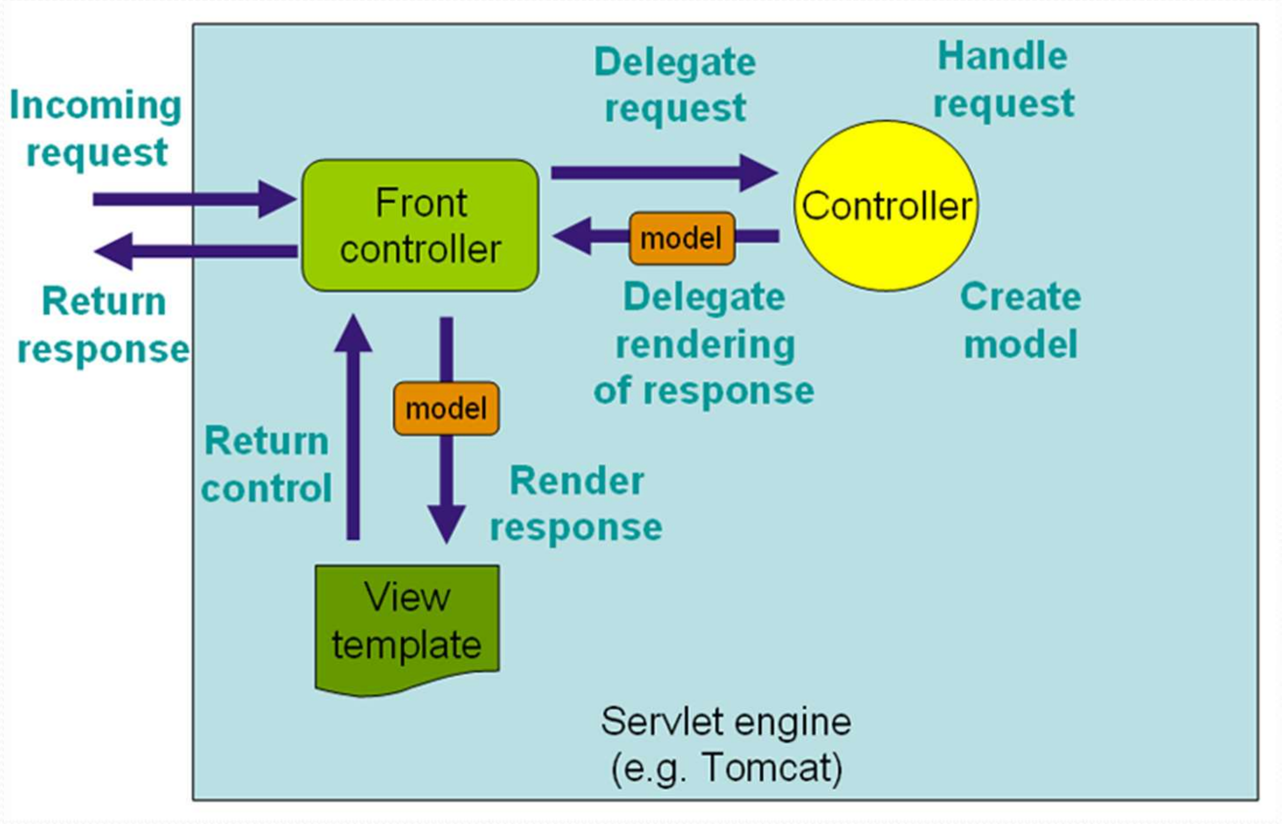
- these four annotations on this configuration class go and set up an entire web container
- they create the DispatcherServlet that we need to route requests to our controllers.
- They automatically scan the appropriate packages that we want to discover our controllers,
- they'll automatically configure our controllers with any dependencies that we want them to have.

ApplicationContext

- If Dependency Injection is the core concept of Spring, then the ApplicationContext is its core object.
- The interface `org.springframework.context.ApplicationContext` represents the Spring IoC container
- It extends the `BeanFactory` interface, in addition to extending other interfaces to provide additional functionality in a more *application framework-oriented style*
- The container gets its instructions on what objects to instantiate, configure, and assemble by reading configuration metadata
- Several implementations of the `ApplicationContext` interface are supplied out-of-the-box with Spring
  - such as ContextLoader that automatically instantiates an `ApplicationContext` as part of the normal startup process

https://docs.spring.io/spring-framework/docs/3.0.0.M4/spring-framework-reference/html/ch15s02.html

MVC Workflow



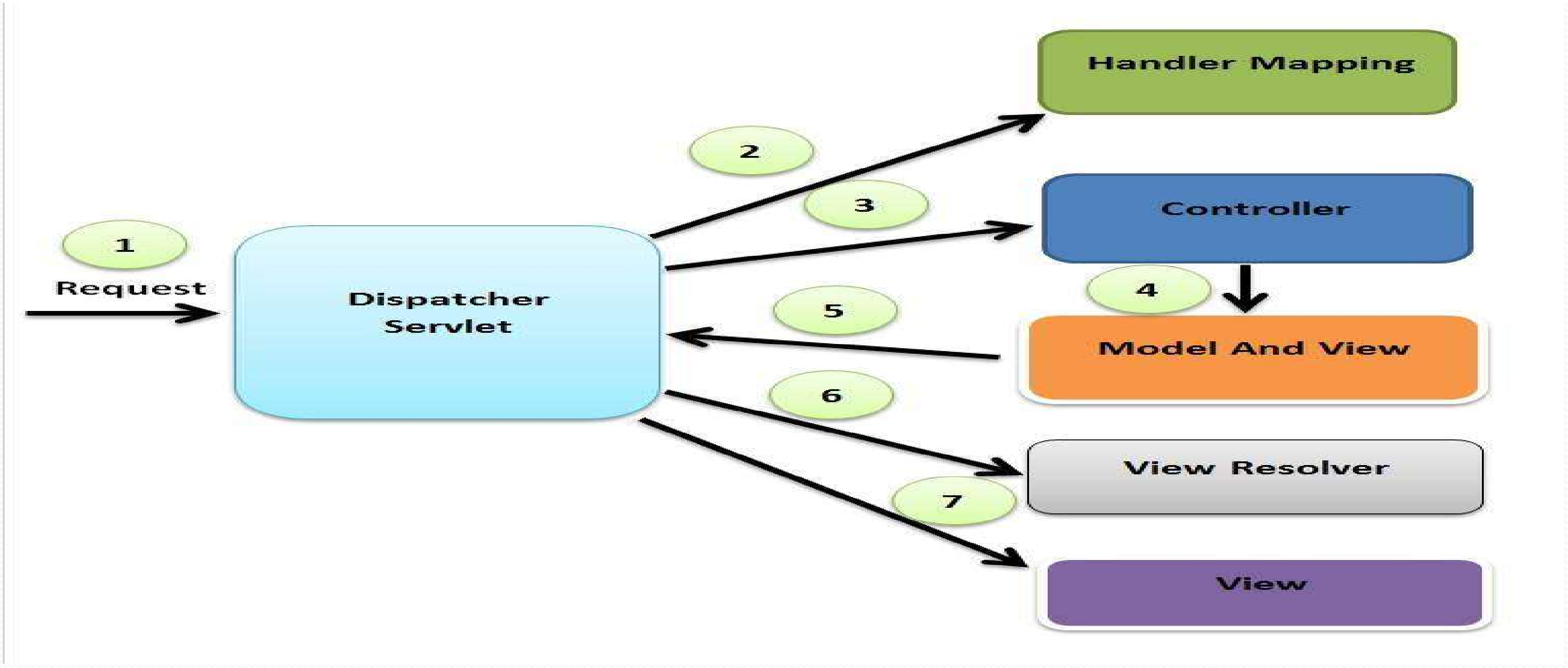
DispatcherServlet

- It gets its name from the fact that it dispatches the request to many different components, each an abstraction of the processing pipeline

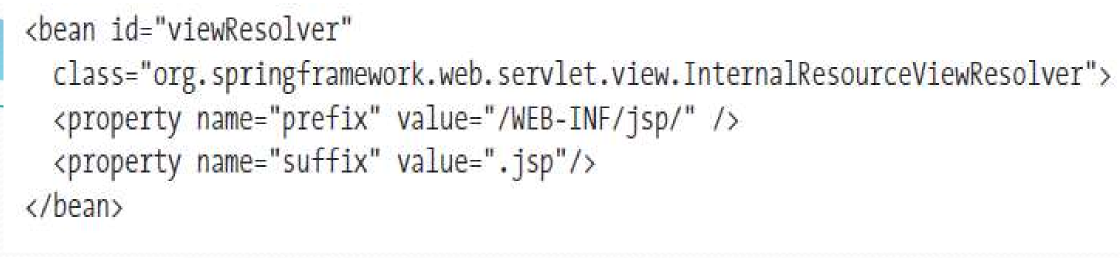
1. Discover the request’s Locale; expose for later usage.
2. Locate which request handler is responsible for this request (e.g., a Controller).
3. Locate any request interceptors for this request. Interceptors are like filters, but customized for Spring MVC.
4. Invoke the Controller.
5. Call postHandle() methods on any interceptors.
6. If there is any exception, handle it with a HandlerExceptionResolver.
7. If no exceptions were thrown, and the Controller returned a ModelAndView, then render the view. When rendering the view, first resolve the view name to a View instance.

Spring 3.0

- the `DispatcherServlet` is an expression of the “Front Controller” design pattern
- the `@Controller` mechanism also allows you to create RESTful Web sites and applications,
- through the `@PathVarariable` annotation

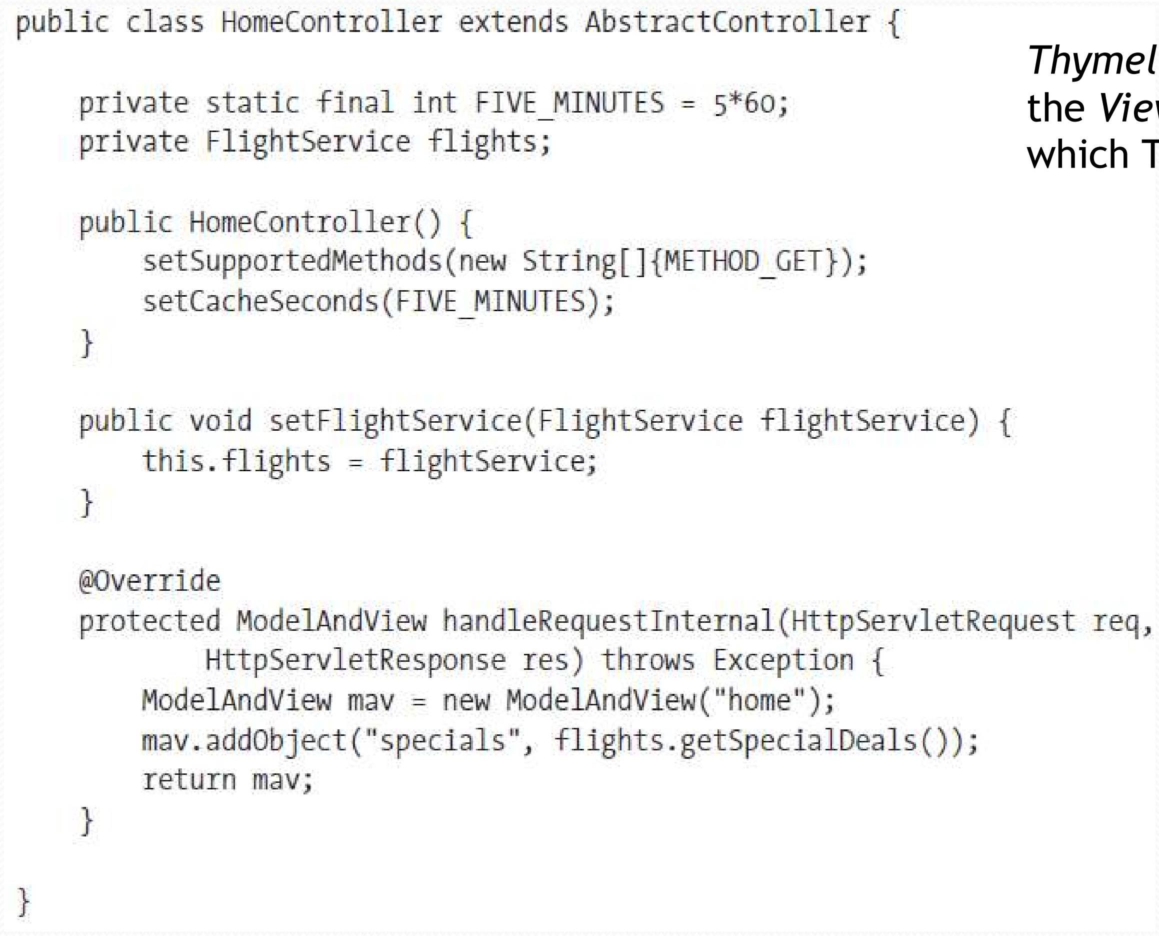


https://docs.spring.io/spring-framework/docs/3.0.0.M4/spring-framework-reference/html/ch15.html



```
<bean id="viewResolver"
  class="org.springframework.web.servlet.view.InternalResourceViewResolver">
  <property name="prefix" value="/WEB-INF/jsp/" />
  <property name="suffix" value=".jsp"/>
</bean>
```

ThymeleafViewResolver implements the *ViewResolver* interface and is used to determine which Thymeleaf views to render, given a view name



```
public class HomeController extends AbstractController {

    private static final int FIVE_MINUTES = 5*60;
    private FlightService flights;

    public HomeController() {
        setSupportedMethods(new String[]{METHOD_GET});
        setCacheSeconds(FIVE_MINUTES);
    }

    public void setFlightService(FlightService flightService) {
        this.flights = flightService;
    }

    @Override
    protected ModelAndView handleRequestInternal(HttpServletRequest req,
            HttpServletResponse res) throws Exception {
        ModelAndView mav = new ModelAndView("home");
        mav.addObject("specials", flights.getSpecialDeals());
        return mav;
    }

}
```

Java Persistence API

- @Entity
- public class Person {
-   @Id
-   @GeneratedValue(strategy = GenerationType.*AUTO*)
-   private long id;

-   private String firstName;
-   private String lastName;
- Getter and setter methods, constructors both versions }

Create the repository

- `public interface PersonRepository extends CrudRepository<Person, Long> {`
- `  List<Person> findByFirstName(String firstName);`
- `}`

- Invoke the database through dependency injection
- @RepositoryRestResource(collectionResourceRel = "people", path = "people")
  - At runtime, Spring Data REST automatically creates an implementation of this interface.
  - collectionResourceRel -The rel value to use when generating links to the collection resource.
  - Path-The path segment under which this resource is to be exported.

- Then it uses the @RepositoryRestResource annotation to direct Spring MVC to create RESTful endpoints at /people

Application properties

- Hibernate ddl auto (create, create-drop, update)

```
spring.jpa.hibernate.ddl-auto=update
```

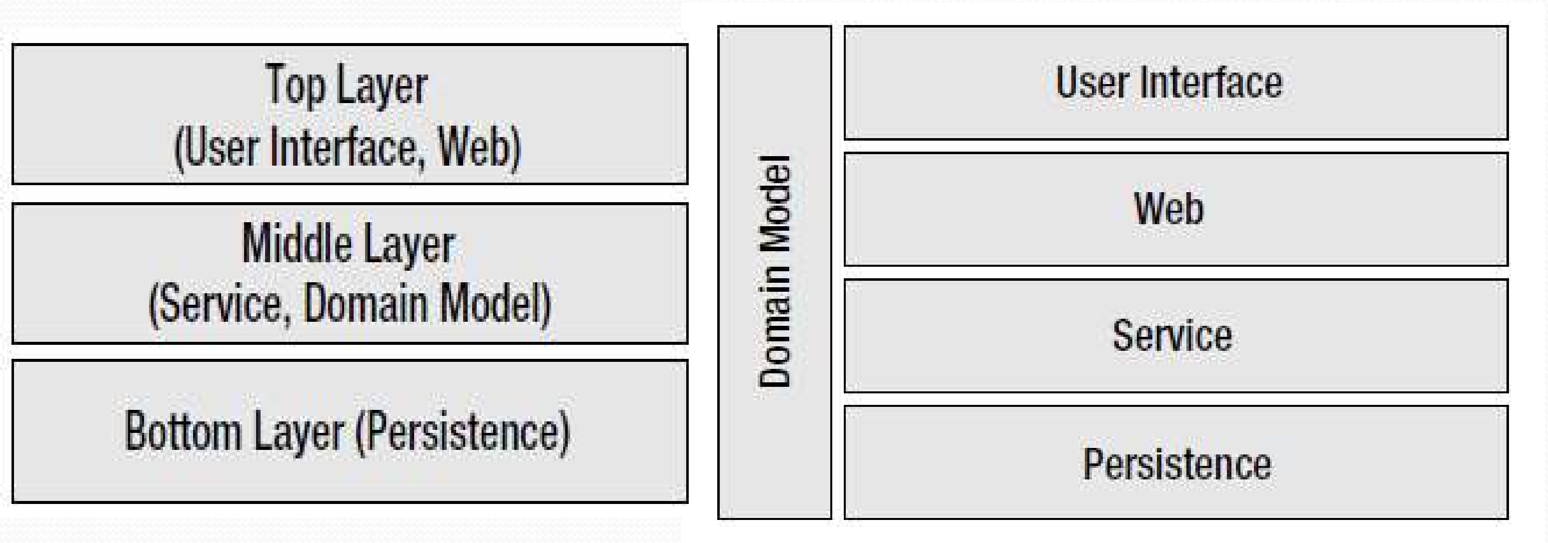
- none: The default for MySQL. No change is made to the database structure.
- update: Hibernate changes the database according to the given entity structures.
- create: Creates the database every time but does not drop it on close.
- create-drop: Creates the database and drops it when SessionFactory closes

- `spring.jpa.show-sql=true`
- The simplest way is to dump the queries to standard out

Application.properties

- `spring.datasource.url=jdbc:mysql://localhost:3306/testconnect`
- `spring.datasource.username=root`
- `spring.datasource.password=1234`
- `spring.datasource.driver-class-name=com.mysql.cj.jdbc.Driver`
- `spring.jpa.properties.hibernate.dialect=org.hibernate.dialect.MySQL5InnoDBDialect`
  - Advanced translation of PersistenceExceptions to Spring DataAccessException
  - Applying specific transaction semantics such as custom isolation level or transaction timeout

Architecture of Spring MVC



Isolating problem domains, such as persistence, web navigation, and user interface, into separate layers creates a flexible and testable application

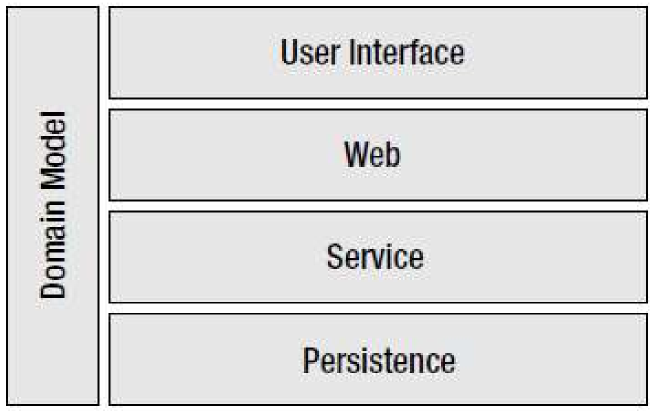
If we find that a layer has permeated throughout many layers, consider if that layer is itself an aspect of the system.

The interface is a contract for a layer, making it easy to keep implementations and their details hidden while enforcing correct layer usage.

Layers in Spring MVC

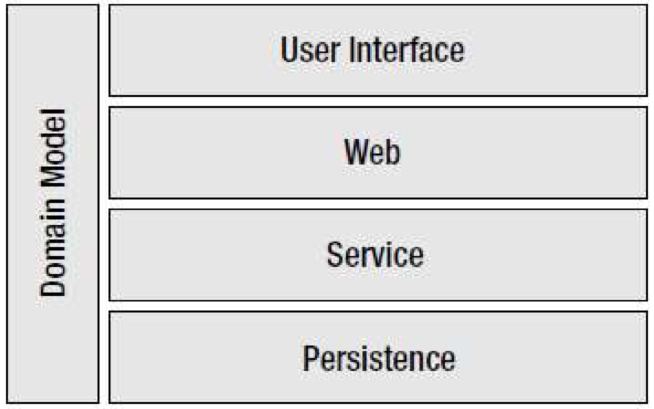
- User Interface Layer
  - This layer renders the response generated by the web layer into the form requested by the client
  - The act of rendering a response for a client is separate from the act of gathering the response
  - Other requests can be processed in the underlying layers while packets are sent and gathered to render the user interface
- There are many toolkits for rendering the user interface
  - Some examples include JSP, Thymeleaf, Angular, and XSLT (all of which are well supported by Spring)
- UI designers typically work with a different toolset and are focused on a different set of concerns than the developers
  - Providing them with a layer dedicated to their needs shields them from the internal details of much of the system

User Interface Layer



- The org.springframework.web.servlet.View interface represents a view, or page, of the web application
- Each view technology will provide an implementation of this interface
  - Spring MVC natively supports JSP, XSLT, Excel, and PDF
- The org.springframework.web.servlet.ViewResolver provides a helpful layer of indirection.
- The ViewResolver provides a map between view instances and their logical names
- The view layer typically has a dependency on the domain model
  - Much of the convenience of using Spring MVC for form processing comes from the fact that the view is working directly with a domain object
  - Often the system isn't that decoupled because the view-specific classes are nearly one-to-one reflections on the domain classes

Web Layer



- Navigation logic is one of the two important functions handled by the web layer
  - Managing the user experience and travels through the site is a unique responsibility of the web layer
  - Many of the layers assume much more of a stateless role.
    - The web layer, however, typically does contain some state to help guide the user through the correct path.
  - There typically isn't any navigation logic in the domain model or service layer; it is the sole domain of the web layer---flexible design customized for users
- The web layer's second main function is to provide the glue between the service layer and the world of HTTP.
- It becomes a thin layer, delegating to the service layer for all coordination of the business logic.
- The web layer is concerned with request parameters, HTTP session handling, HTTP response codes

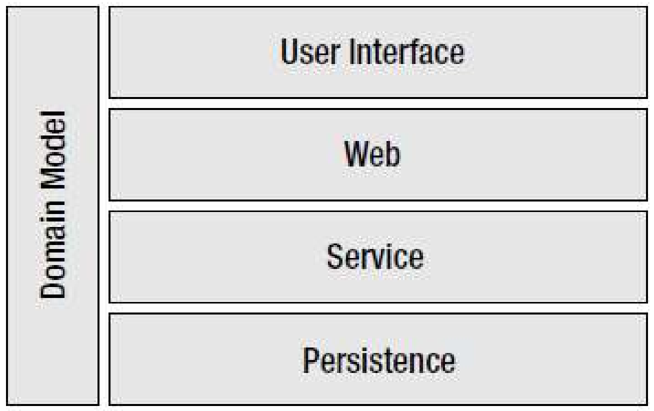
Web Layer

- The web layer is dependent on the service layer and the domain model.
- The web layer will delegate its processing to the service layer, and it is responsible for converting information sent in from the web to domain objects sufficient for calls into the service layer
- Spring MVC provides an org.springframework.web.servlet.mvc.Controller interface for implementing web layer
- The Controller is responsible for accepting the HttpServletRequest and the HttpServletResponse, performing some unit of work, and passing off control to a View.

Service Layer

- This layer exposes and encapsulates coarse-grained system functionality (use cases) for easy client usage
- Client is shielded from all the POJO interactions that implement the use case by using the service layer
- No single method call on a service object should assume any previous method calls to itself.
- Any state across method calls is kept in the domain model
- In a typical Spring MVC application, a single service layer object will handle many concurrent threads of execution
- This layer attempts to provide encapsulations of all the use cases of the system.
- A single use case is often one transactional unit of work
- It also makes it easy to refer to one layer for all the high-level system functionality

Service layer

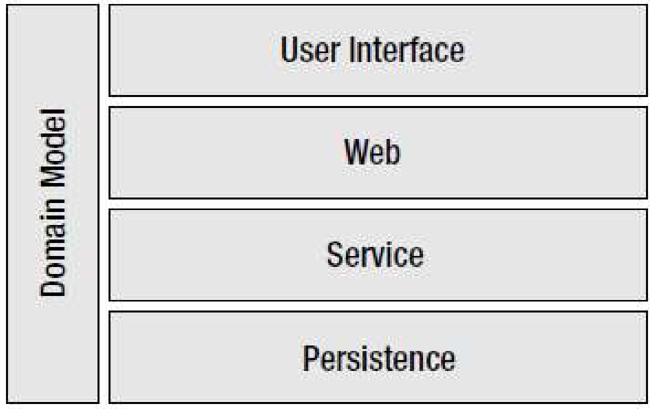


- The service layer is dependent upon the domain model and the persistence layer
- It combines and coordinates calls to both the data access objects and the domain model objects.
- The service layer should never have a dependency on the view or web layers.
- Instead of defining your business interfaces, Spring helps with the programming model.
  - Typically, the Spring Framework's ApplicationContext will inject instances of the service into the web Controllers.
  - Spring will also enhance our service layer with services such as transaction management and performance monitoring

Domain Model Layer

- This layer contains the business logic of the system, and thus, the true implementation of the use cases.
- The domain model is the collection of nouns in the system, implemented as POJOs.
- These nouns, such as User, Address, and ShoppingCart, contain both state (user's first name, user's last name) and behavior (shoppingCart.purchase())
- Centralizing the business logic inside POJOs makes it possible to take advantage of core object-oriented principles and practices, such as polymorphism and inheritance
- Any logic the system performs to satisfy some rule or constraint dictated by the customer is considered business logic.
- This can include anything from complex state verification to simple validation rules
  - there are some business rules that live in the database, in the form of constraints such as UNIQUE or NOT NULL
- The domain model should contain most of the business logic, but place the logic outside the model when there is a good reason

Domain model layer



- Many other layers have dependencies on the domain model.
- It is important to note, however, that **the object has no dependencies on any other layer**
- The business logic can be tested outside of the container and independently of the framework
- This speeds up development tremendously, as no deployments are required for testing
- Each layer is responsible for their problem domains, but they all live to service the domain model
  - The service layer typically combines multiple methods from the domain model together to run under one transaction.
  - The user interface layer might serialize the domain model for a client into XML or XHTML.
  - The data access layer is responsible for persisting and retrieving instances of the objects from the model.
- Spring can provide services like dependency injection in this layer

Domain model layer

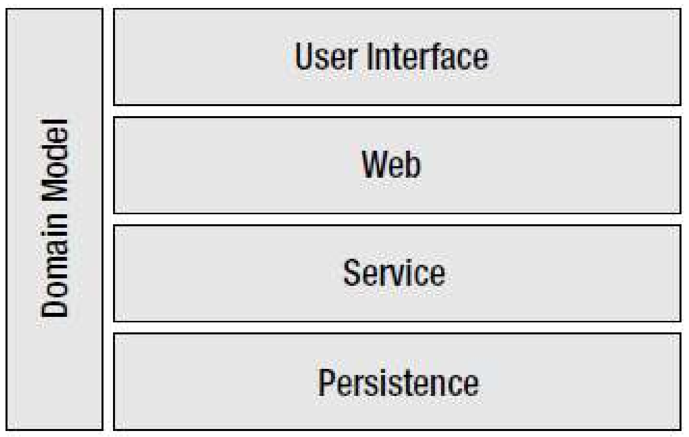
- Spring does an excellent job of creating POJOs and wiring them together.
- This works well when the object is actually created and initialized by Spring, but this isn’t always the case with objects in the domain model.
- These instances can come from outside the ApplicationContext, for instance loaded directly by the database.

Data Access Layer

- The data access layer is responsible for interfacing with the persistence mechanism to store and retrieve instances of the object model
- Typically, only the service layer has a dependency on the data access layer
- Spring does provide common patterns for interacting with the data access layer
- For example, the template pattern is often used by data access operations to shield the implementer from common initialization and cleanup code

Use Case

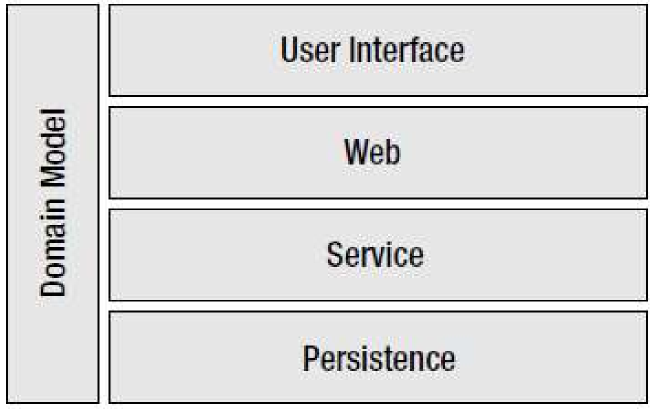
- A list of current special deals must appear on the home page.
- Each special deal must display the departure city, the arrival city, and the cost.
- These special deals are set up by the marketing department and change during the day, so it can’t be static.
- Special deals are only good for a limited amount of time.

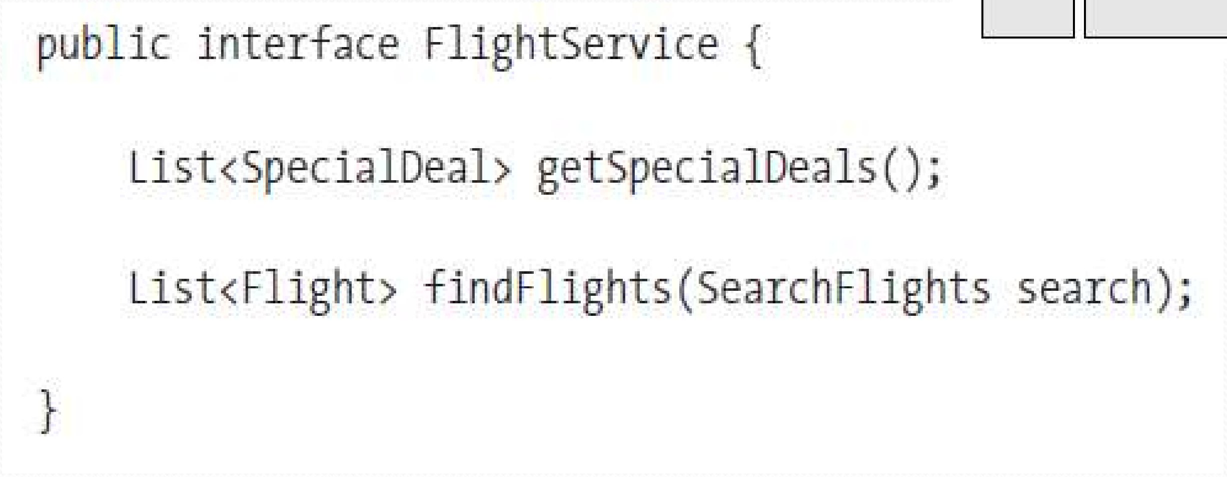


Service Interface

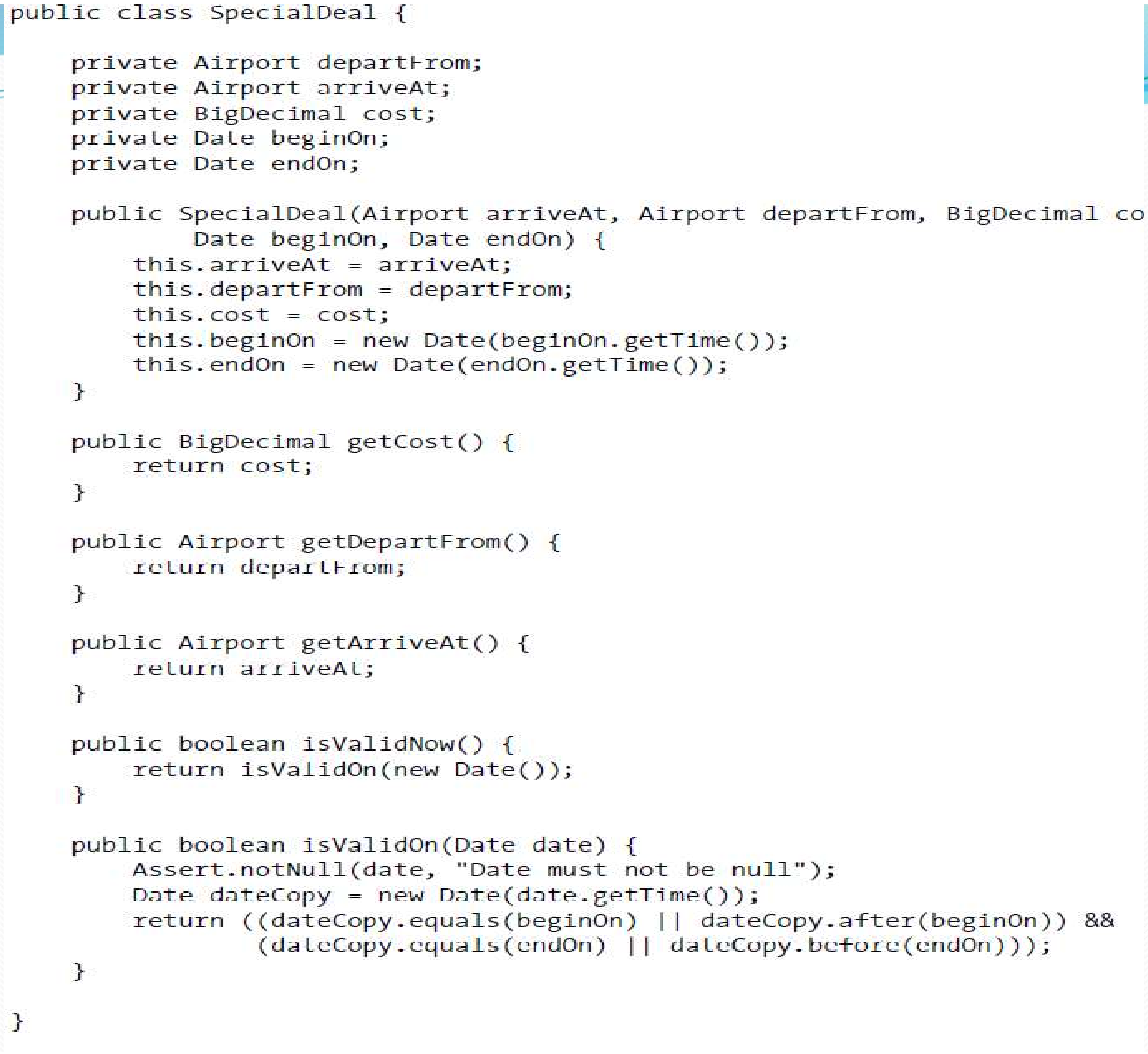
- Creating the interface first also allows development work to begin on the web layer, before the actual interface implementation is complete
- The use case doesn’t specify any type of uniqueness to the special deals.
  - Every user will see the same special deals when they view the home page
- Airports will be instances of the Airport class so that we can encapsulate both the name and airport code
- This interface provides easy access to the use cases through the façade pattern
  - These methods are coarse grained and stateless
    - Multiple calls into the methods may happen concurrently without side effects
- coarse grained to indicate that a single method call will accomplish the use case, instead of many small calls.

FlightService interface





```
public interface FlightService {

    List<SpecialDeal> getSpecialDeals();

    List<Flight> findFlights(SearchFlights search);

}
```



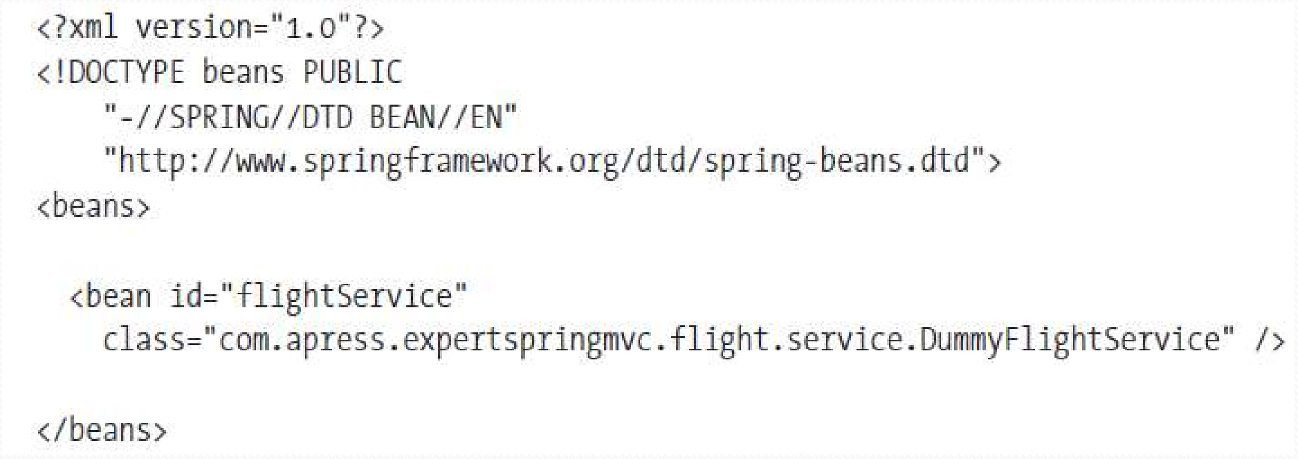
```java
public class SpecialDeal {

    private Airport departFrom;
    private Airport arriveAt;
    private BigDecimal cost;
    private Date beginOn;
    private Date endOn;

    public SpecialDeal(Airport arriveAt, Airport departFrom, BigDecimal co
            Date beginOn, Date endOn) {
        this.arriveAt = arriveAt;
        this.departFrom = departFrom;
        this.cost = cost;
        this.beginOn = new Date(beginOn.getTime());
        this.endOn = new Date(endOn.getTime());
    }

    public BigDecimal getCost() {
        return cost;
    }

    public Airport getDepartFrom() {
        return departFrom;
    }

    public Airport getArriveAt() {
        return arriveAt;
    }

    public boolean isValidNow() {
        return isValidOn(new Date());
    }

    public boolean isValidOn(Date date) {
        Assert.notNull(date, "Date must not be null");
        Date dateCopy = new Date(date.getTime());
        return ((dateCopy.equals(beginOn) || dateCopy.after(beginOn)) &&
                (dateCopy.equals(endOn) || dateCopy.before(endOn)));
    }

}
```

Service Interface

- For applications where rounding imprecisely can cause problems, such as interest calculations, use BigDecimal
- For objects that are not immutable, like Date, it’s a best practice to make your own copies of the arguments before storing in the class or using with some business logic
  - Defensive copies
- Limited time special deals
- To encapsulate this logic, beginOn and endOn properties are added along with isValidOn() and isValidNow() methods
- The class is immutable because it models more correctly an immutable concept (a special deal can’t change, but it can be deleted and a new one can take its place)

Design decisions

- First we developed both a domain object model and a service layer
- FlightService implementation is defined as a Spring bean inside the applicationContext.xml so that it may be easily injected into our web components



```
<?xml version="1.0"?>
<!DOCTYPE beans PUBLIC
    "-//SPRING//DTD BEAN//EN"
    "http://www.springframework.org/dtd/spring-beans.dtd">
<beans>

  <bean id="flightService"
    class="com.apress.expertspringmvc.flight.service.DummyFlightService" />

</beans>
```

- Router →servlet
- Router→method of a Controller

Web layer

- Install the jars
- In pom.xml
  - <dependency>
    - <groupId>org.springframework</groupId>
    - <artifactId>spring-webmvc</artifactId>
    - <version>4.2.2.RELEASE</version>
  - </dependency>
- Spring MVC delegates the responsibility for handling HTTP requests to Controllers
- Controllers are responsible for processing HTTP requests, performing whatever work necessary, composing the response objects, and passing control back to the main request handling work flow
- The Controller does not handle view rendering, focusing instead on handling the request and response objects and delegating to the service layer
- Views can render more than just text output. Other bundled view rendering toolkits include
  - PDF
  - Excel
  - JasperReports (an open-source reporting tool)

Controller

- When processing is complete, the Controller is responsible for building up the collection of objects that make up the response (the Model) as well as choosing what page (or View) the user sees next
- This combination of Model and View is encapsulated in a class named ModelAndView
- the Model is a Map of arbitrary objects, and the View is typically specified with a logical name.
- The view’s name is later resolved to an actual View instance, later in the processing pipeline.
- It is the View’s responsibility to intelligently display and render the objects in the Model.

Simple Controller

- @Controller
- public class LoginController { @RequestMapping(value = "/login")
- @ResponseBody
- public String sayHello() {
- return "Hello World dummy";
- } }

Controller for the Use case

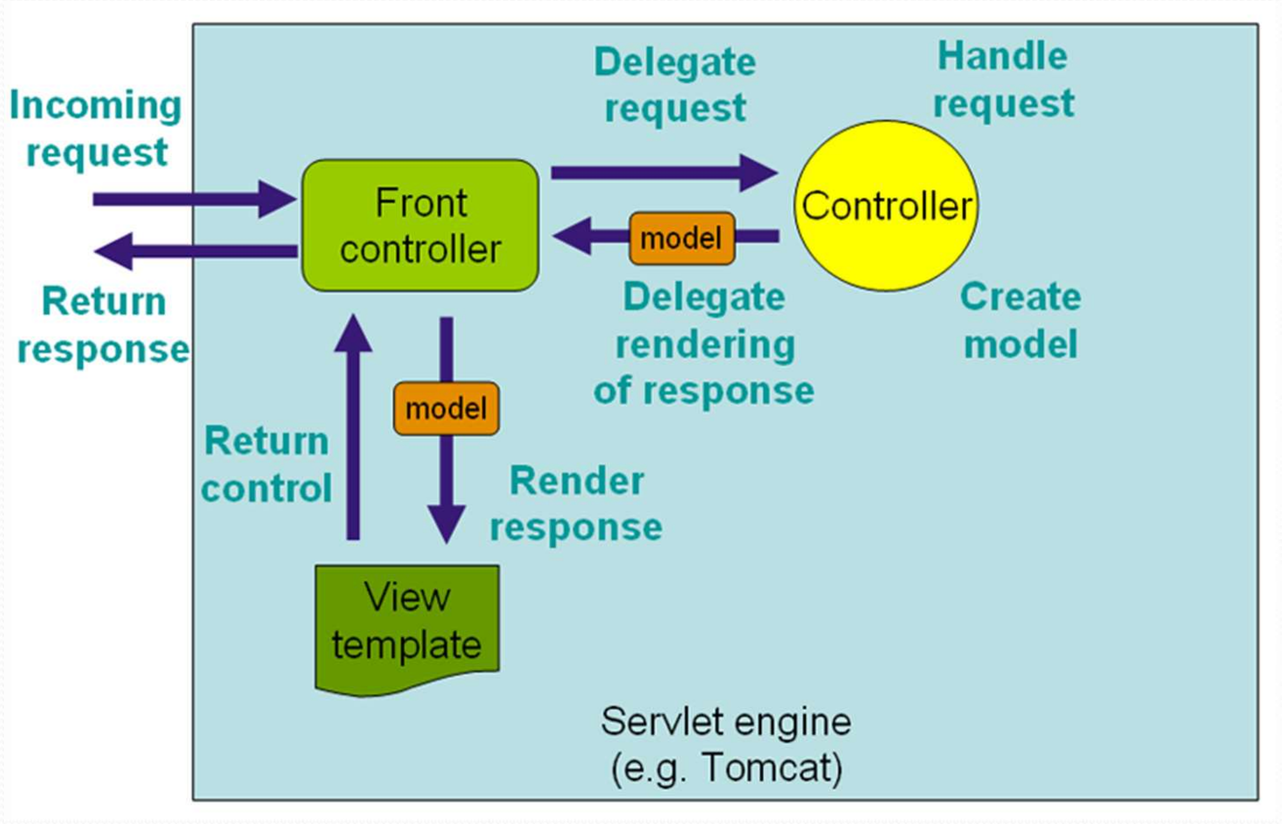
- The most basic Controller implementation is an org.springframework.web.servlet.mvc.
- AbstractController, perfect for read-only pages and simple requests.
- Well suited for web resources that return dynamic information but don’t respond to input
- It provides facilities such as controlling caching via HTTP headers and enforcing certain HTTP methods

```java
public class HomeController extends AbstractController {

    private static final int FIVE_MINUTES = 5*60;
    private FlightService flights;

    public HomeController() {
        setSupportedMethods(new String[]{METHOD_GET});
        setCacheSeconds(FIVE_MINUTES);
    }

    public void setFlightService(FlightService flightService) {
        this.flights = flightService;
    }

    @Override
    protected ModelAndView handleRequestInternal(HttpServletRequest req,
            HttpServletResponse res) throws Exception {
        ModelAndView mav = new ModelAndView("home");
        mav.addObject("specials", flights.getSpecialDeals());
        return mav;
    }

}
```

Controller

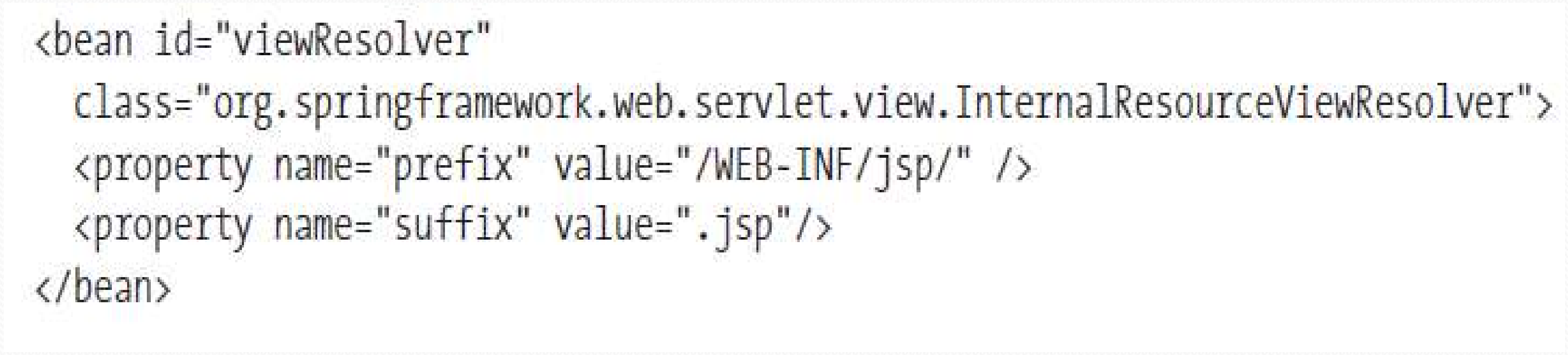
- The constructor configures this Controller to respond only to HTTP GET requests, because GET has semantics that most closely match that of “read.”
- The constructor instructs the superclass to send the appropriate HTTP headers to enable caching
- By default, AbstractController will send the appropriate headers to disable caching
- setCacheSeconds() method replaced by a <property name="cacheSeconds" value="300" /> XML snippet
- XML for external issues such as wiring the classes together, or for configuration elements that have a reasonable chance of changing
- The setFlightService() method is a clear sign that the HomeController will require Dependency Injection to obtain an instance of FlightService
- The special deals are pulled from the FlightService and placed directly into the model with the name specials
- The view layer will use this name to locate the list of special deals.
- The ModelAndView instance is constructed with the view name home, used to identify which view to render for this Controller.
- These logical view names are used to keep the Controller decoupled from the view technology.

MVC Workflow



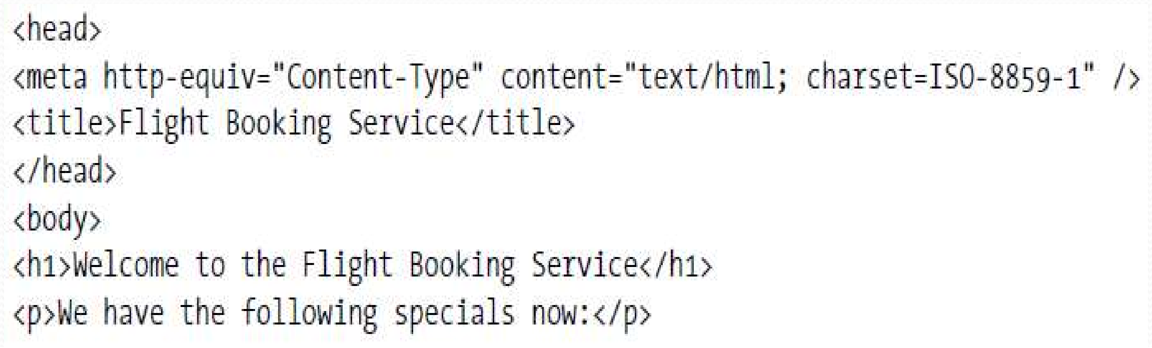
View layer

- For our JSP files, the simple org.springframework.web.servlet.view.InternalResourceViewResolver will provide the perfect view resolution

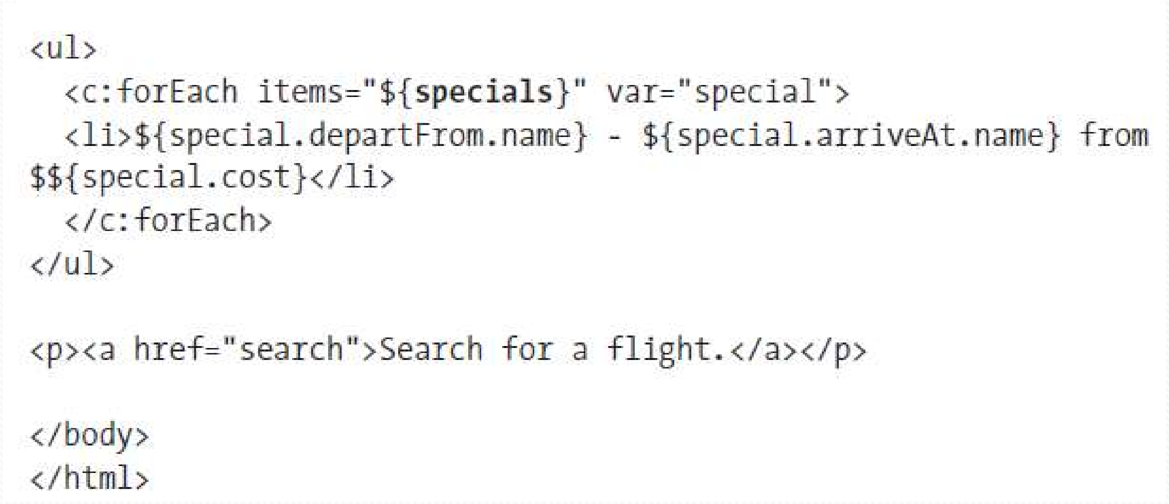


```
<bean id="viewResolver"
  class="org.springframework.web.servlet.view.InternalResourceViewResolver">
  <property name="prefix" value="/WEB-INF/jsp/" />
  <property name="suffix" value=".jsp"/>
</bean>
```

View Layer for the Use case



```
<head>
<meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1" />
<title>Flight Booking Service</title>
</head>
<body>
<h1>Welcome to the Flight Booking Service</h1>
<p>We have the following specials now:</p>
```

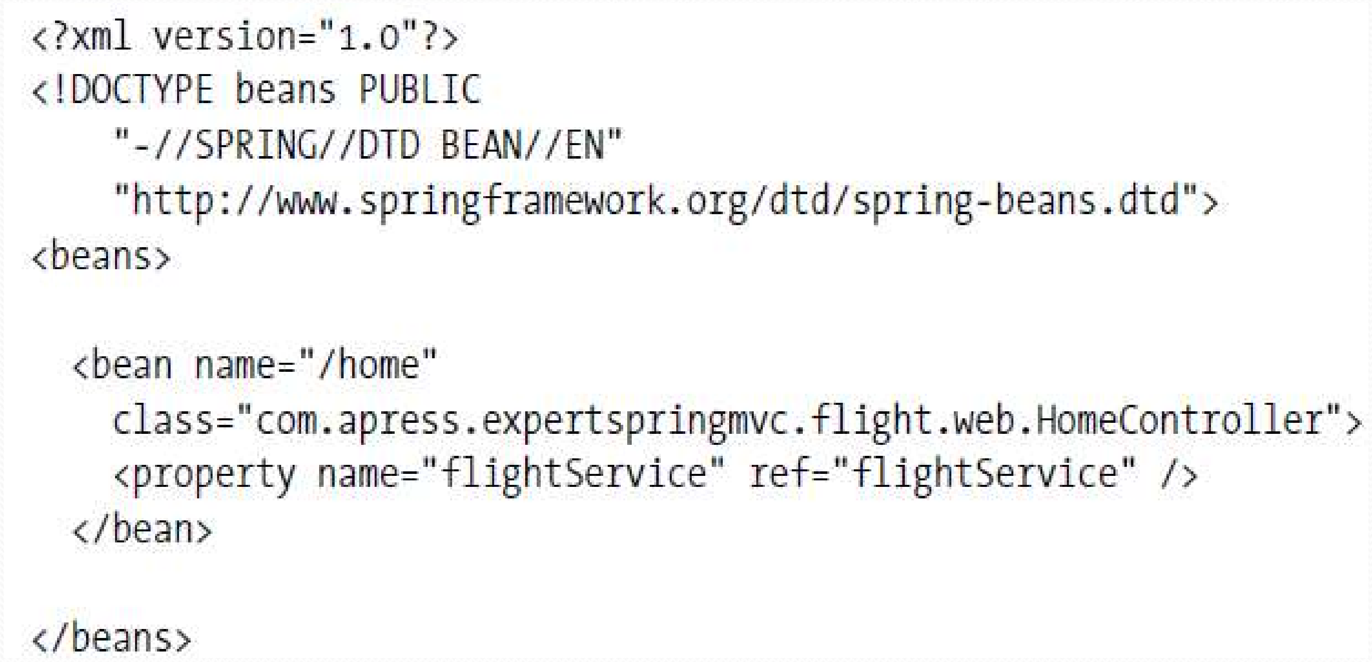


```
<ul>
  <c:forEach items="${specials}" var="special">
  <li>${special.departFrom.name} - ${special.arriveAt.name} from
$${special.cost}</li>
  </c:forEach>
</ul>

<p><a href="search">Search for a flight.</a></p>

</body>
</html>
```

Summary of Web Layer Implementation

- The HomeController delegates to the FlightService to find any special deals and then places those deals inside a ModelAndView.
- This ModelAndView object is returned from the Controller, bringing along with it the name of the view to render.
- The view name is resolved to a JSP file by an InternalResourceViewResolver, which creates a full resource path by combining a prefix, the view name, and a suffix.
- The InternalResourceViewResolver and HomeController are defined and configured in the spring-servlet.xml file, which defines all the beans that make up the web components application context

Spring-servlet.xml



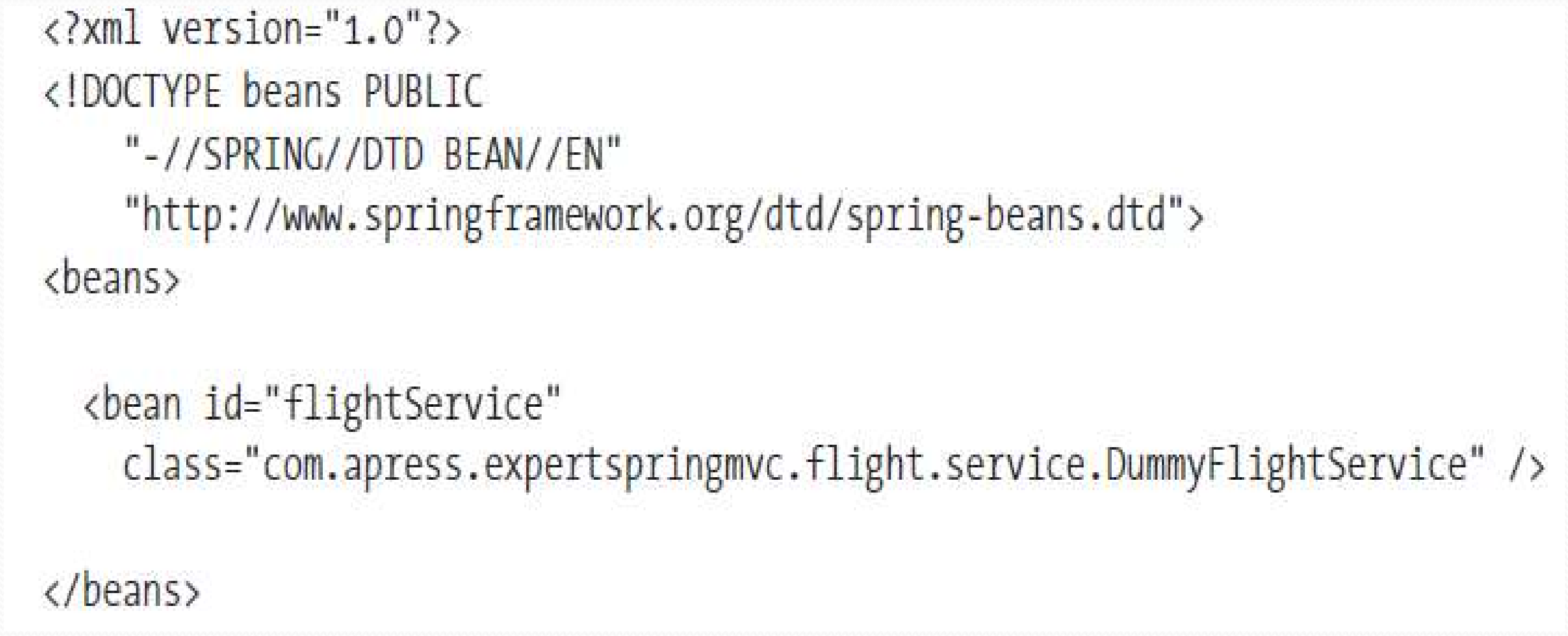
```
<?xml version="1.0"?>
<!DOCTYPE beans PUBLIC
    "-//SPRING//DTD BEAN//EN"
    "http://www.springframework.org/dtd/spring-beans.dtd">
<beans>

  <bean name="/home"
    class="com.apress.expertspringmvc.flight.web.HomeController">
    <property name="flightService" ref="flightService" />
  </bean>

</beans>
```

- <bean id="viewResolver"
- class="org.springframework.web.servlet.view.InternalResourceViewResolver">
- <property name="prefix" value="/WEB-INF/jsp/" />
- <property name="suffix" value=".jsp"/>
- </bean>

Application Context configuration

- Spring MVC applications usually have two ApplicationContexts configured in a parent-child relationship
- The parent context, or root ApplicationContext, contains all of the non–web specific beans such as the services, DAOs, and supporting POJOs.
- Root ApplicationContext contains the FlightService implementation, and is named applicationContext.xml.
  - This ApplicationContext must be initialized before the web-specific resources are started
- The ContextLoaderListener is used to create root ApplicationContext, responding to the contextInitialized() callback of a ServletContextListener
- Once the ApplicationContext is built it will be placed into the application scope of the web application so that the entire application may access it

Application-context.xml



```
<?xml version="1.0"?>
<!DOCTYPE beans PUBLIC
    "-//SPRING//DTD BEAN//EN"
    "http://www.springframework.org/dtd/spring-beans.dtd">
<beans>

  <bean id="flightService"
    class="com.apress.expertspringmvc.flight.service.DummyFlightService" />

</beans>
```

Root application context

- applicationContext.xml is the root context configuration for every web application.
- Spring loads applicationContext.xml file and creates the ApplicationContext for the whole application.
- If you are not explicitly declaring the context configuration file name in web.xml using the contextConfigLocation param, Spring will search for the applicationContext.xml under WEB-INF folder and throw FileNotFoundException if it could not find this file.

Web application context

- There can be multiple **WebApplicationContext** in a single web application.
- Each DispatcherServlet associated with single WebApplicationContext.
- xxx-servlet.xml file is specific to the DispatcherServlet and a web application can have more than one DispatcherServlet configured to handle the requests
    - In such scenarios, each DispatcherServlet would have a separate xxx-servlet.xml configured.
    - But, applicationContext.xml will be common for all the servlet configuration files
- Spring will by default load file named "xxx-servlet.xml" from your webapps WEB-INF folder where xxx is the servlet name in web.xml
- If you want to change the name of that file name or change the location, add initi-param with contextConfigLocation as param name.

DispatcherServlet

- The Spring (MVC) framework is designed around a DispatcherServlet that dispatches requests to handlers, with configurable handler mappings, view resolution
- A Front Controller as “a controller that handles all requests for a Web site.”
- DispatcherServlet serves the role of a Front Controller
- The response from a Controller is rendered for output by an instance of the View class

DispatcherServlet

- When the DispatcherServlet initializes, it will search the WebApplicationContext for one or more instances of the elements that make up the processing pipeline (such as ViewResolvers)
- WebApplicationContext is a special ApplicationContext implementation of the servlet environment and the ServletConfig object
- To locate the XML for the WebApplicationContext, the DispatcherServlet will by default take the name of its servlet definition from web.xml, append -servlet.xml, and look for that file in /WEB-INF
  - if the servlet is named spring, it will look for a file named /WEB-INF/spring-servlet.xml

web.xml

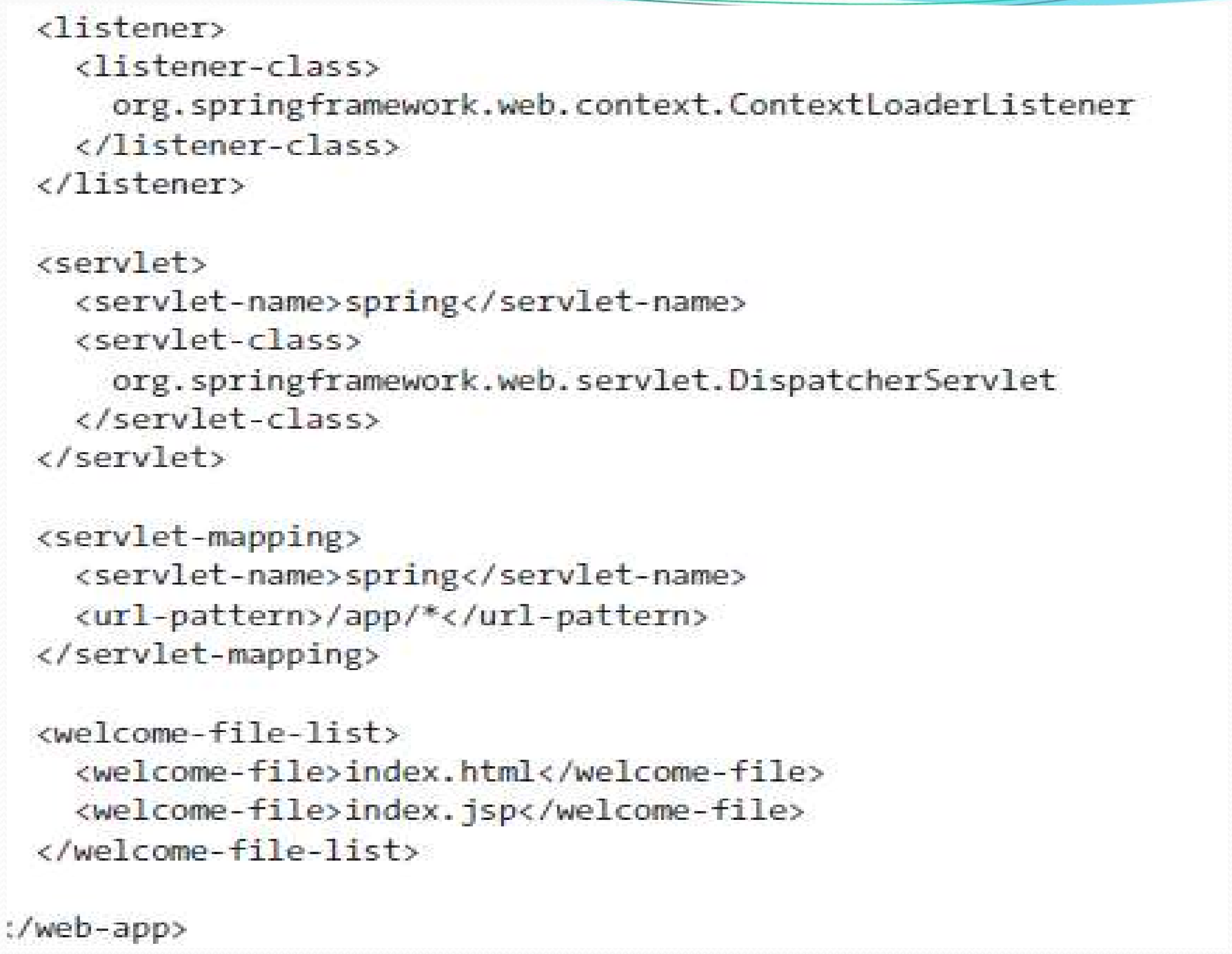
- <web-app...>
-     <servlet>
    - <servlet-name>spring</servlet-name>
    - <servlet-class>
      org.springframework.web.servlet.DispatcherServlet
    - </servlet-class>
    - <init-param>
    - <param-name>contextConfigLocation</param-name>
    - <param-value>/WEB-INF/application-servlet.xml</param-value>
      </init-param>
    - <load-on-startup>1</load-on-startup>
  - </servlet>
  - <servlet-mapping>
    - <servlet-name>spring</servlet-name>
    - <url-pattern>/app/*</url-pattern>
  - </servlet-mapping>
- </web-app>

http://www.example.com/JumpIntoSpringMVC/app/home

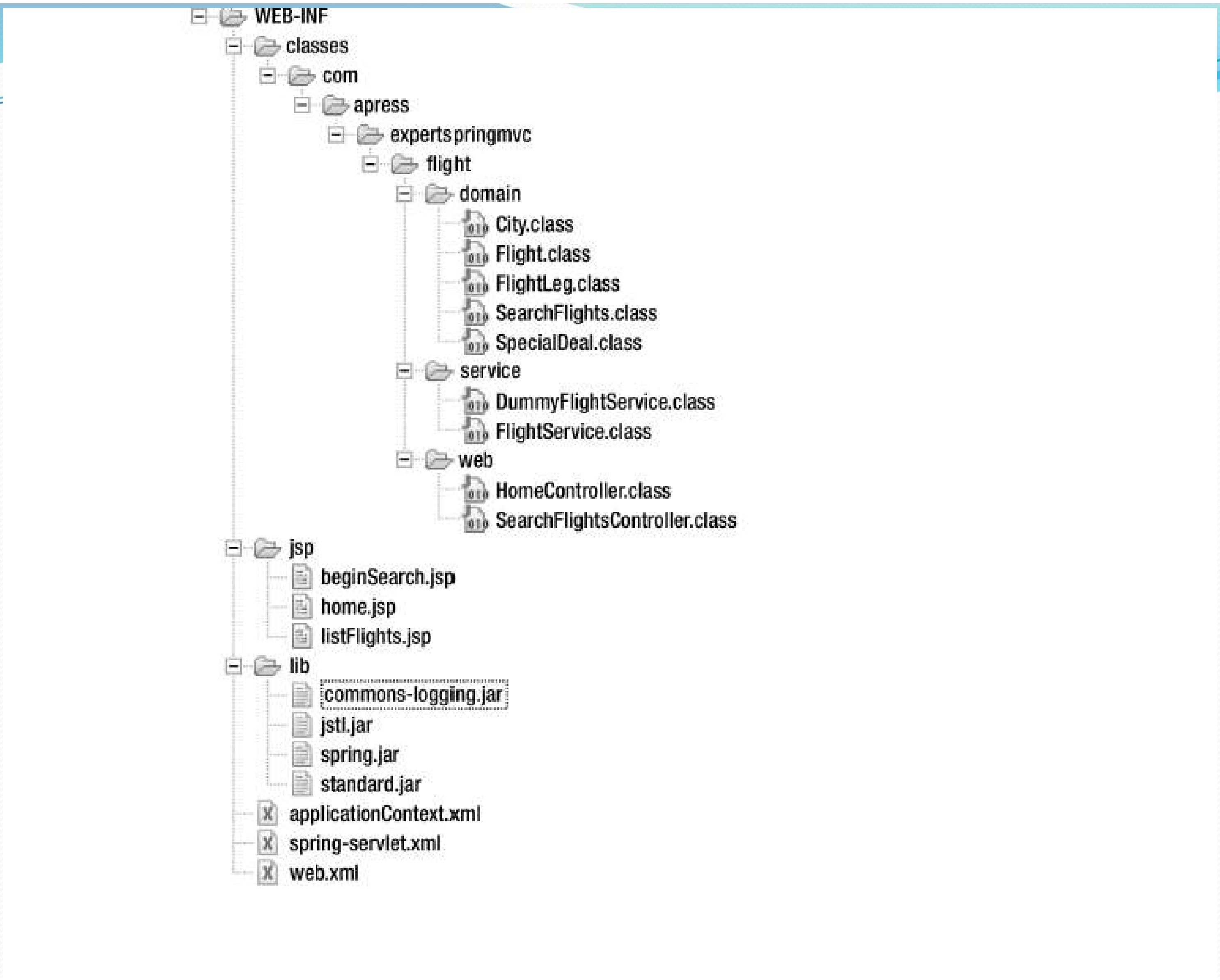
Configuration

- <servlet>
- <servlet-name>dispatcher</servlet-name>
- <servlet-class> org.springframework.web.servlet.DispatcherServlet </servlet-class>
- <init-param><param-name> contextConfigLocation</param-name>
- <param-value>/WEB-INF/todo-servlet.xml</param-value>
- </init-param><load-on-startup>1</load-on-startup>
- </servlet>

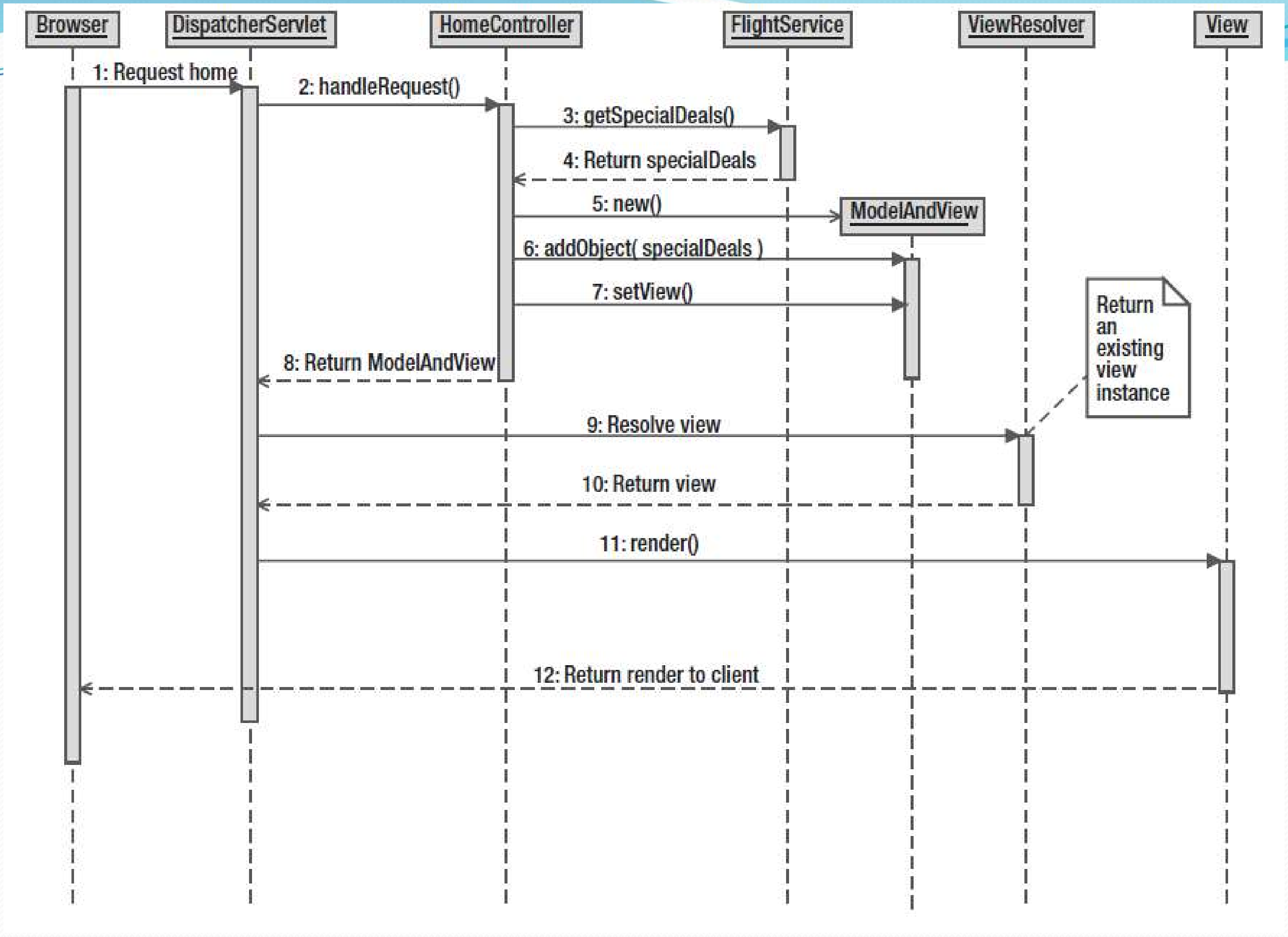
Web.xml



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

<servlet>
  <servlet-name>spring</servlet-name>
  <servlet-class>
    org.springframework.web.servlet.DispatcherServlet
  </servlet-class>
</servlet>

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

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

:/web-app>
```



```
WEB-INF
├─ classes
│  └─ com
│     └─ apress
│        └─ expertspringmvc
│           └─ flight
│              ├─ domain
│              │  ├─ City.class
│              │  ├─ Flight.class
│              │  ├─ FlightLeg.class
│              │  ├─ SearchFlights.class
│              │  └─ SpecialDeal.class
│              ├─ service
│              │  ├─ DummyFlightService.class
│              │  └─ FlightService.class
│              └─ web
│                 ├─ HomeController.class
│                 └─ SearchFlightsController.class
├─ jsp
│  ├─ beginSearch.jsp
│  ├─ home.jsp
│  └─ listFlights.jsp
├─ lib
│  ├─ commons-logging.jar
│  ├─ jstl.jar
│  ├─ spring.jar
│  └─ standard.jar
├─ applicationContext.xml
├─ spring-servlet.xml
└─ web.xml
```


Browser
DispatcherServlet
HomeController
FlightService
ViewResolver
View
1: Request home
2: handleRequest()
3: getSpecialDeals()
4: Return specialDeals
5: new()
ModelAndView
6: addObject(specialDeals)
7: setView()
Return an existing view instance
8: Return ModelAndView
9: Resolve view
10: Return view
11: render()
12: Return render to client

BeanFactory

- The ApplicationContext is a specialization of a BeanFactory, which is the registry of all the objects managed by Spring.
- Under normal circumstances, the BeanFactory is responsible for
    - creating the beans,
    - wiring them with any dependencies, and
    - providing a convenient lookup facility for the beans.
- Other interfaces are there to help to define the life cycle of beans managed by the BeanFactory
- Spring configuration consists of at least one and typically more than one bean definition that the container must manage
- Typically you define service layer objects, data access objects (DAOs), presentation objects

```
ApplicationContext context = new ClassPathXmlApplicationContext(new
String[] {"services.xml", "daos.xml"});
```

ApplicationContext and BeanFactory

- Applications typically interact with an ApplicationContext instead of a BeanFactory
- Additionally ApplicationContext provides internationalization (i18n) facilities for resolving messages

DispatcherServlet

- The WebApplicationContext is a special ApplicationContext implementation that is aware of the servlet environment and the ServletConfig object
- For interfaces like ViewResolvers, the DispatcherServlet can be configured to locate all instances of the same type
- The DispatcherServlet uses the Ordered interface to sort many of its collections of delegates.
  - This is done through a property named *order*
- Usually, the first element to respond with a non-null value wins
- During initialization, the DispatcherServlet will look for all implementations by type of HandlerAdapters, HandlerMappings, HandlerExceptionResolvers, and ViewResolvers
- The DispatcherServlet is configured with default implementations for most of these interfaces.
  - This means that if no implementations are found in the ApplicationContext (either by name or by type), the DispatcherServlet will create and use them