

Spring Core

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Agenda

- Introduction
- Features of Spring
- Spring Framework Architecture
- Inversion of Control in Spring
- Spring Bean
- Using Spring Annotations

August 14, 2017

Introduction

What is Spring Framework ?

- The Spring Framework is an open source application framework created to simplify the development of enterprise Java software.
- The framework provides developers with a component model and a set of simplified and consistent APIs that effectively insulate developers from the complexity and error-prone boilerplate code required to create complex applications.





Why use it?

- Quality:
 - High-quality open source software
 - Well-designed web MVC framework
- Modularity
 - About 20 modules, giving developers the freedom to choose
 - Using existing technologies, also other frameworks
- Promotes best practices
 - Develop enterprise-class applications using POJOs
- Modest learning curve
 - Consistency and simplicity of the APIs
 - Hundreds of resources online
- Popularity
 - Myriad publications, websites, and job postings

Features of Spring



Features of Spring

- Lightweight framework
 - Reducing complexity in application code
 - Don't have a high startup time
 - Don't involve huge binary dependencies

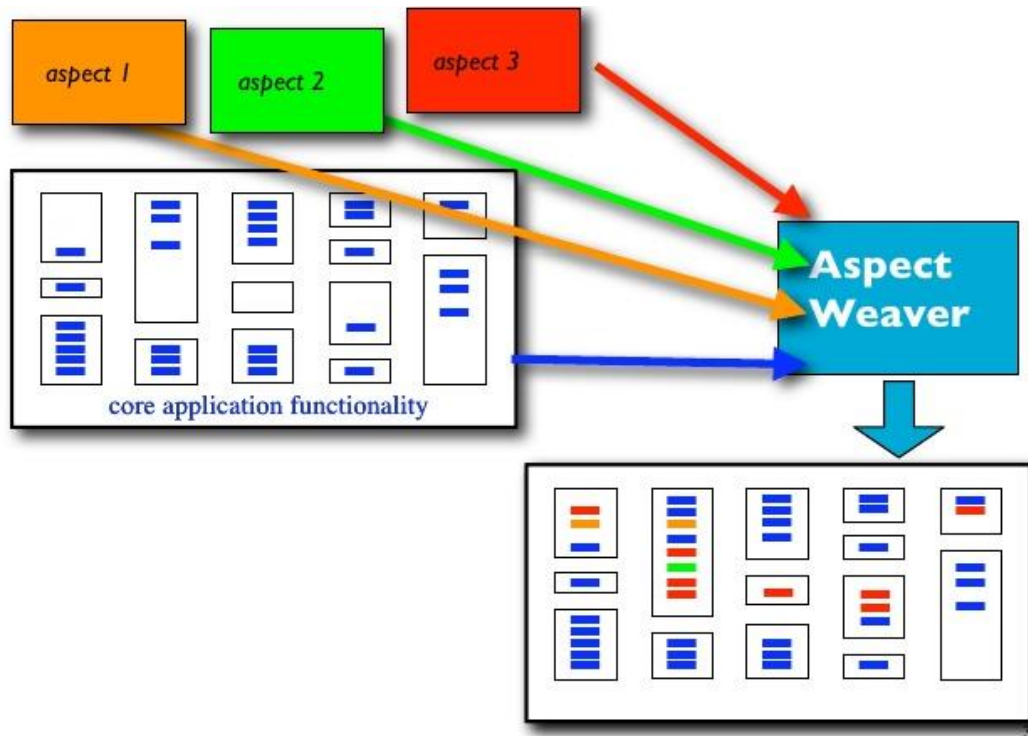
Features of Spring

- Inversion of Control (IoC)
 - Providing an implementation for IoC supporting injection



Features of Spring

- Aspect-oriented Programming (AOP)
 - Isolates supporting functions from the main program's business logic
 - Other system concerns such as logging, security, auditing, locking...





Features of Spring

- Spring MVC Framework
 - Building robust and maintainable web applications
- Spring Web Flow
 - Build on Spring MVC and allows implementing the "flows" of a web application



Features of Spring

- Spring Data
 - Provide a familiar and consistent, Spring-based programming model for data access while still retaining the special traits of the underlying data store
 - Reducing the amount of boilerplate code in the exception handling
- Spring Security
 - Providing security mechanism for Spring-based applications (both authentication and authorization)

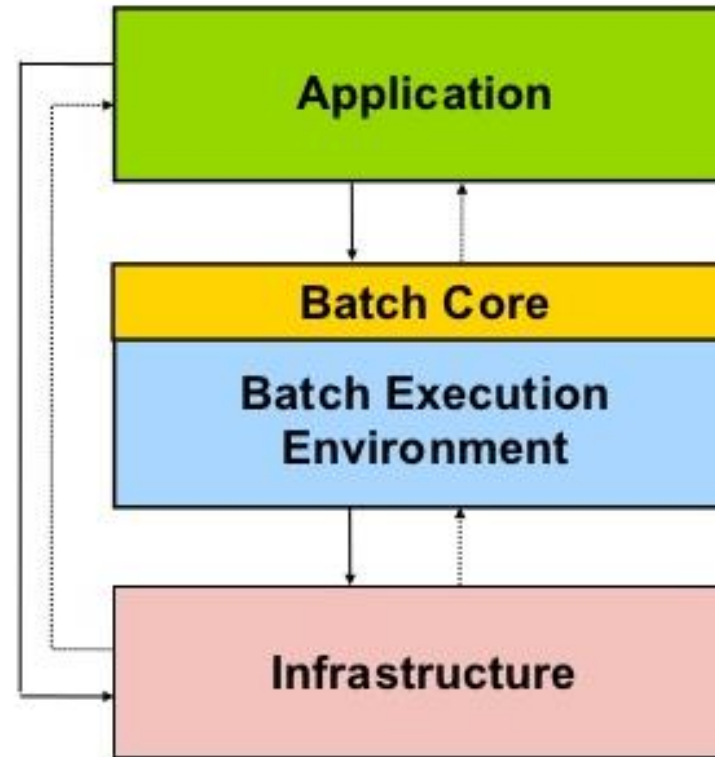
Other features of Spring

- Spring Web Services



Other features of Spring

- Spring Batch
 - Perform bulk operations on data



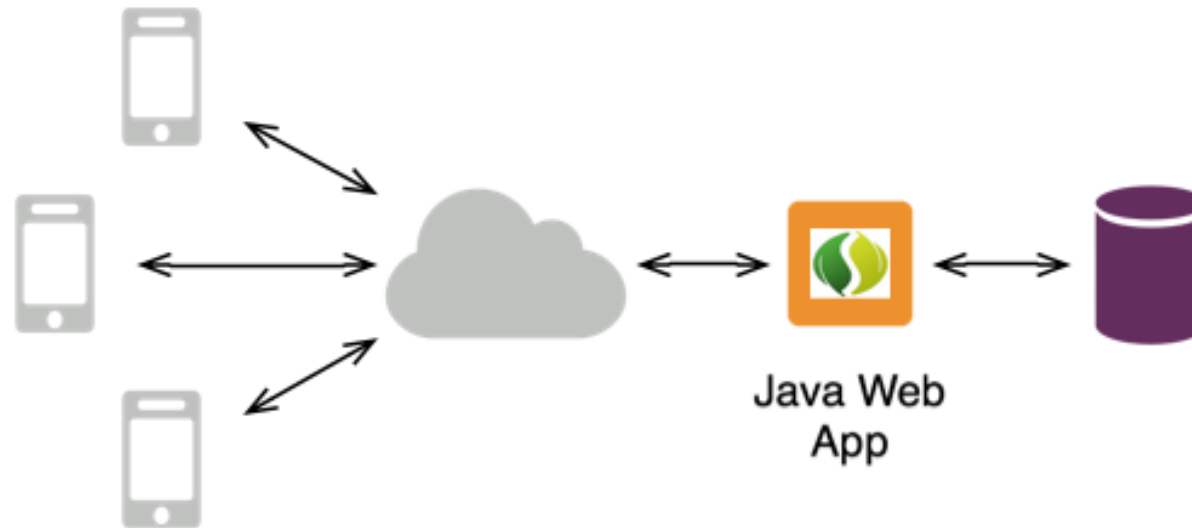
Other features of Spring

- Spring Social
 - Connect Spring Applications with Software-as-a-Service (SaaS) API providers such as Facebook, Twitter, and LinkedIn



Other features of Spring

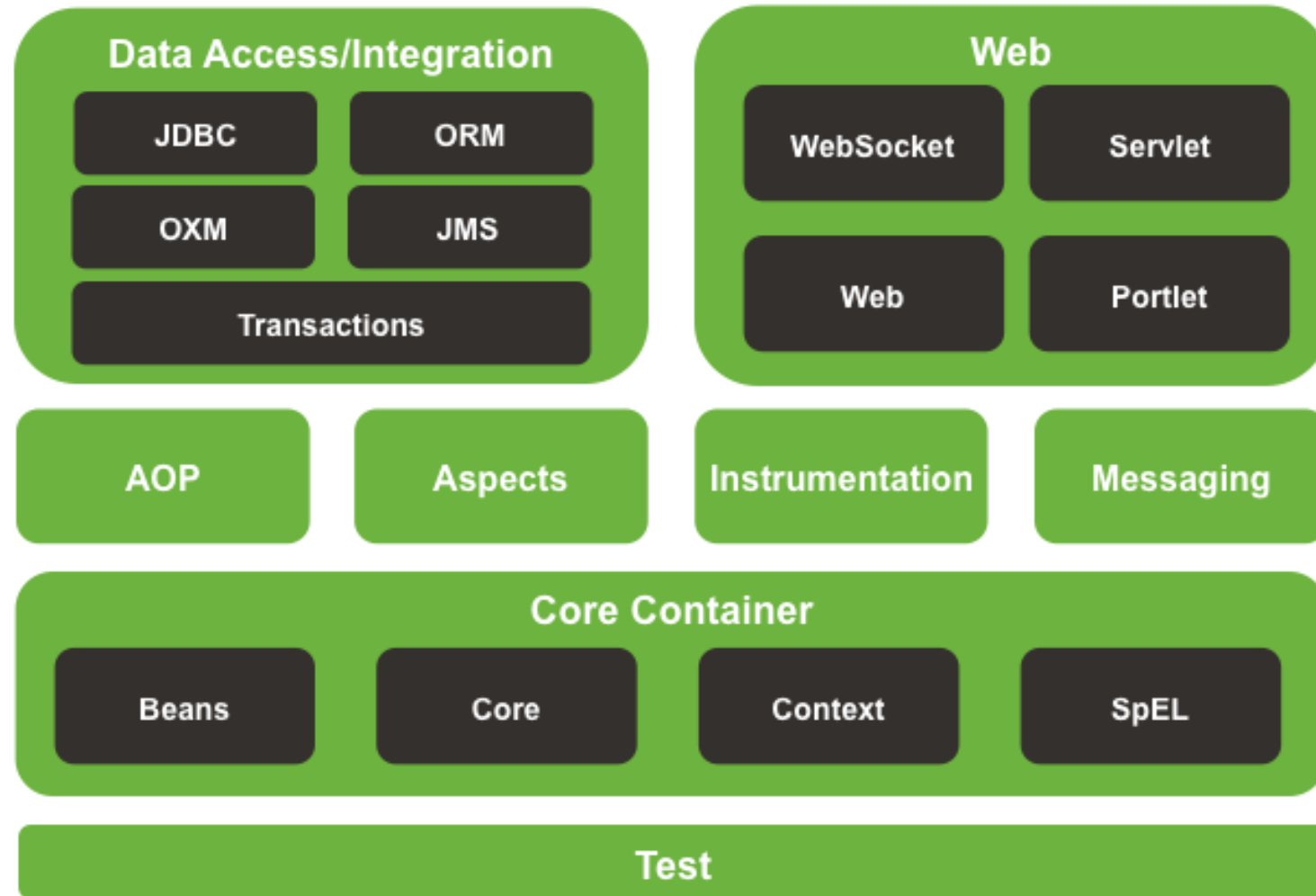
- Spring Mobile
 - Develop mobile web applications



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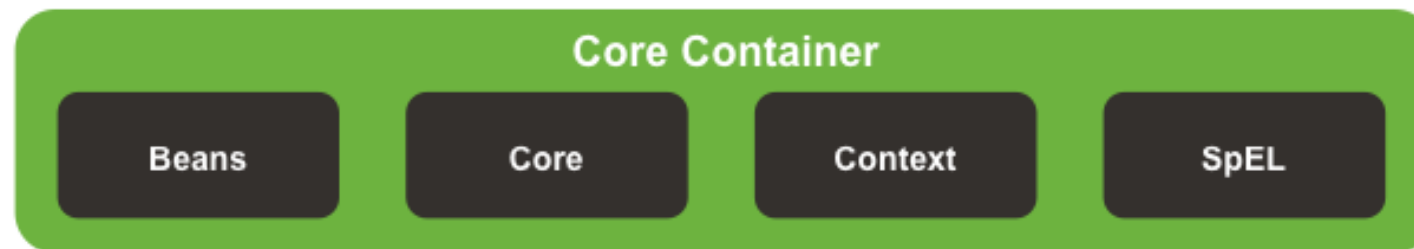
Spring Framework Architecture

Spring Framework Architecture



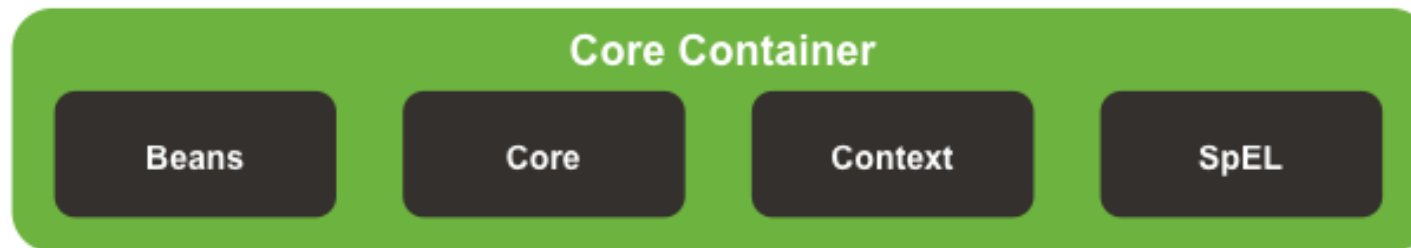
Spring Core Container

- Core module
 - The most important component of the Spring Framework
 - Providing IoC and Dependency Injection
- Beans module
 - Providing BeanFactory



Spring Core Container

- Context module
 - ApplicationContext - loads Spring bean definitions and wires them together
- Spring Expression Language (SpEL)
 - Providing powerful expression language supporting the features for querying and manipulating an object graph at runtime



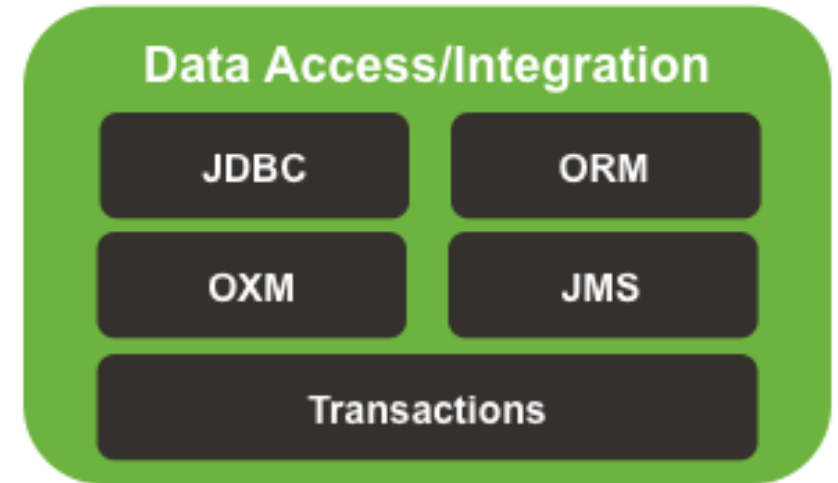
The AOP module

- Providing an AOP implementation
- Spring integrates with AspectJ, which is an extension of AOP
- The Spring Framework uses AOP for providing most of the infrastructure logic in it



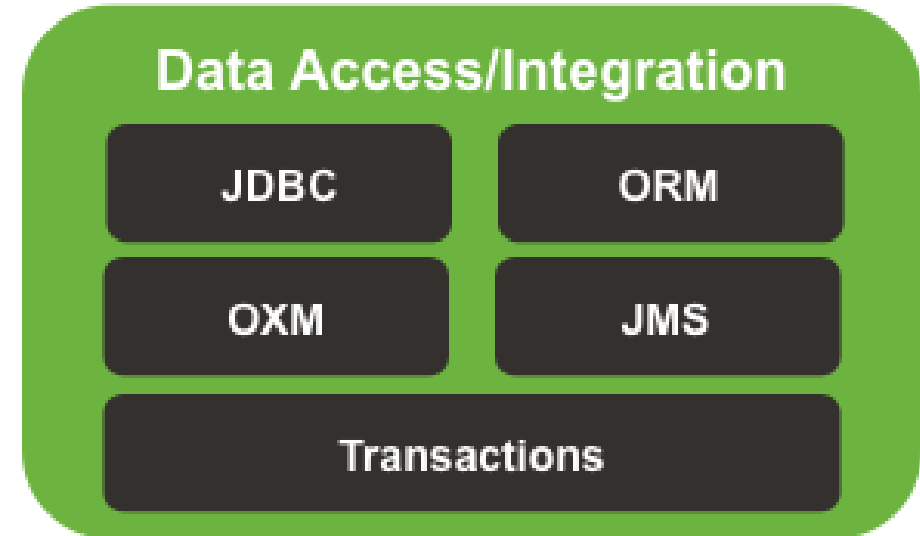
Data access/integration

- JDBC module
 - Providing solution for various problems identified using JDBC
- ORM module
 - Providing a high-level abstraction for ORM APIs, including JPA and Hibernate
- OXM module
 - Supports Object/XML mapping, also integration with Castor, JAXB, XmlBeans, and the XStream framework.



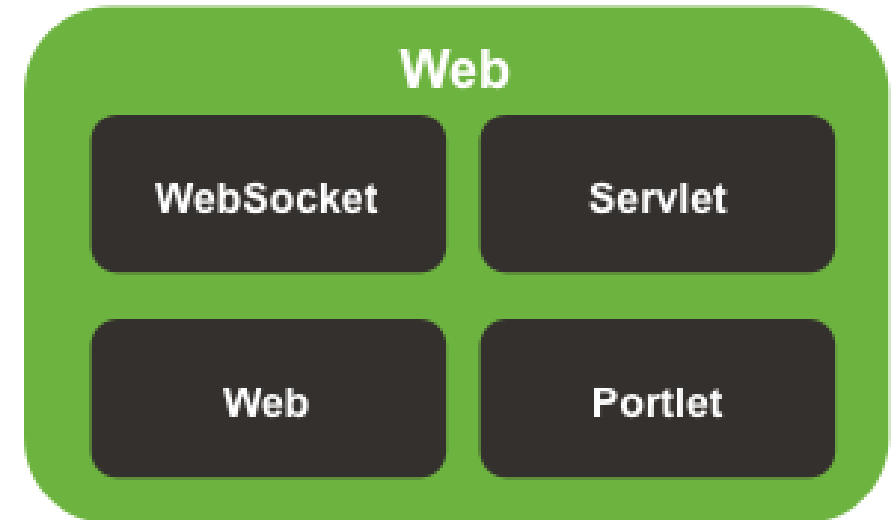
Data access/integration

- JMS module
 - Produce and consume messages
 - Java Message Oriented Middleware (MOM)
API for sending messages between two or more clients.
- Transaction module
 - Provides abstraction mechanism to supports programmatic and declarative transaction management for classes.



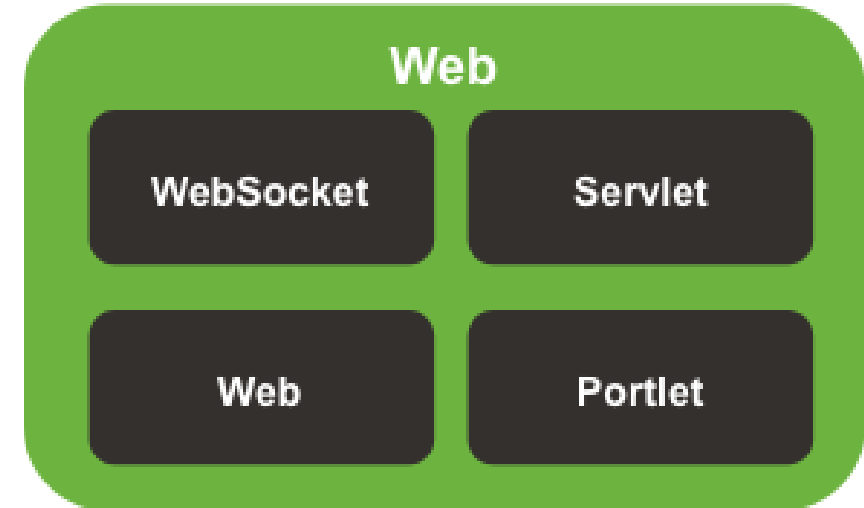
The Web module

- Web module
 - Support for developing robust and maintainable web application in a simplified approach
- Servlet module
 - Model-ViewController (MVC) implementation that helps to build enterprise web applications



The Web module

- Struts module
 - Supports integration of Struts Web tier within a Spring application
- Portlet module
 - Supports for easier development of web application using Spring with Portlet



The Test module

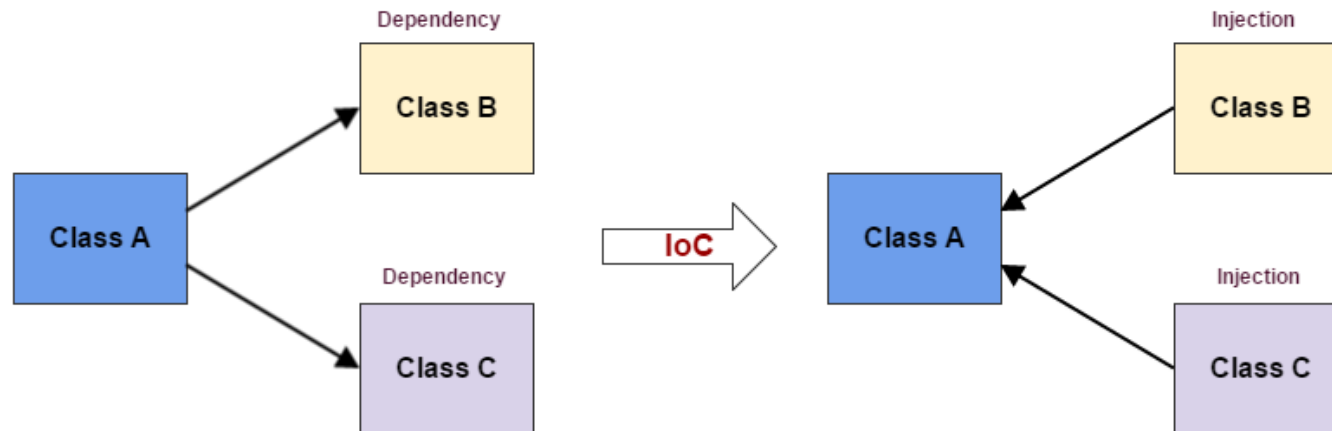
Test

- Helps to test applications developed using the Spring Framework
- Using JUnit or TestNG, also helps in creating mock object to perform unit testing in isolation

Inversion of Control in Spring

Understanding Inversion of Control

- IoC is a programming technique in which object coupling is bound at runtime by an assembler object and is usually not known at compile time using static analysis
- IoC is a more general concept, whereas DI is a concrete design pattern

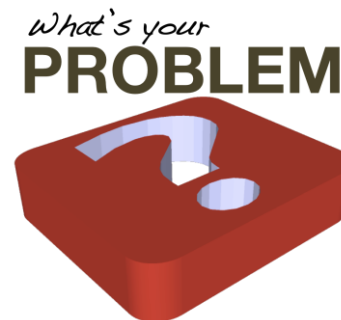


Understanding Inversion of Control



```
public class ReportGenerator {  
    private PDFWriter pdfWriter;  
  
    public ReportGenerator(){  
        pdfWriter = new PDFWriter();  
    }  
  
    public void generateReport(){  
        pdfWriter.writeData();  
    }  
}
```

```
public class PDFWriter {  
    public void writeData(){  
        System.out.println("Write data into pdf file.");  
    }  
}  
  
public static void main(String[] args) {  
    ReportGenerator generator = new ReportGenerator();  
    generator.generateReport();  
}
```



Understanding Inversion of Control

- How about Excel/CSV or XML format or ... ?

```
public class ReportGenerator {  
    private PDFWriter pdfWriter;  
  
    public ReportGenerator(PDFWriter pdfWriter){  
        this.pdfWriter = pdfWriter;  
    }  
  
    public void generateReport(){  
        pdfWriter.writeData();  
    }  
}
```

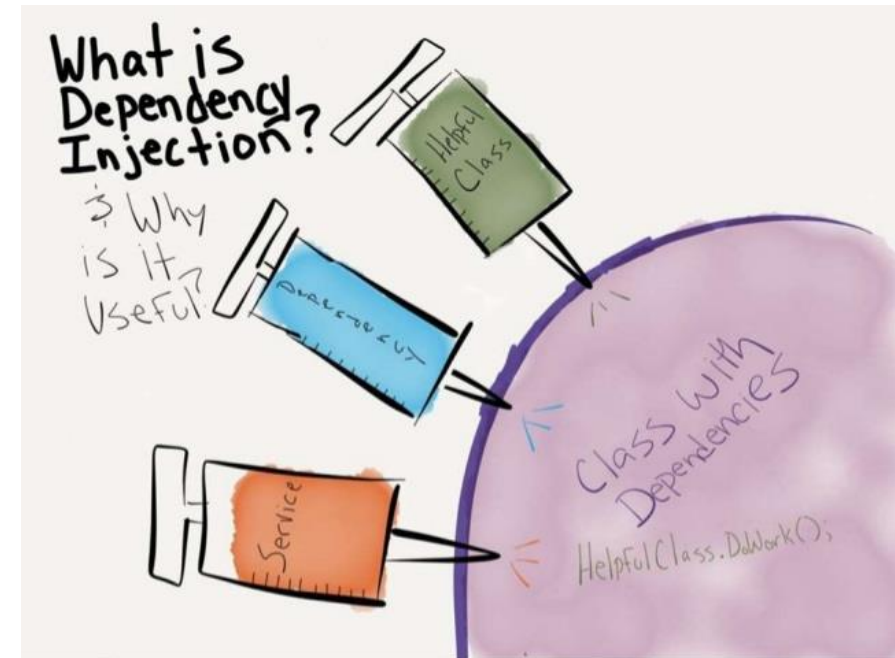
```
public static void main(String[] args) {  
  
    PDFWriter pdf = new PDFWriter();  
  
    ReportGenerator generator = new ReportGenerator(pdf);  
    generator.generateReport();  
}
```

Understanding Inversion of Control

- Each object is responsible for obtaining its own references to the objects it collaborates with (its dependencies)
 - **Tight coupling**
 - **Hard-to-test code**
- Java components/classes should be as independent as possible.
 - **Reusability**
 - **Flexibility**
 - **Testability**

Dependency Injection

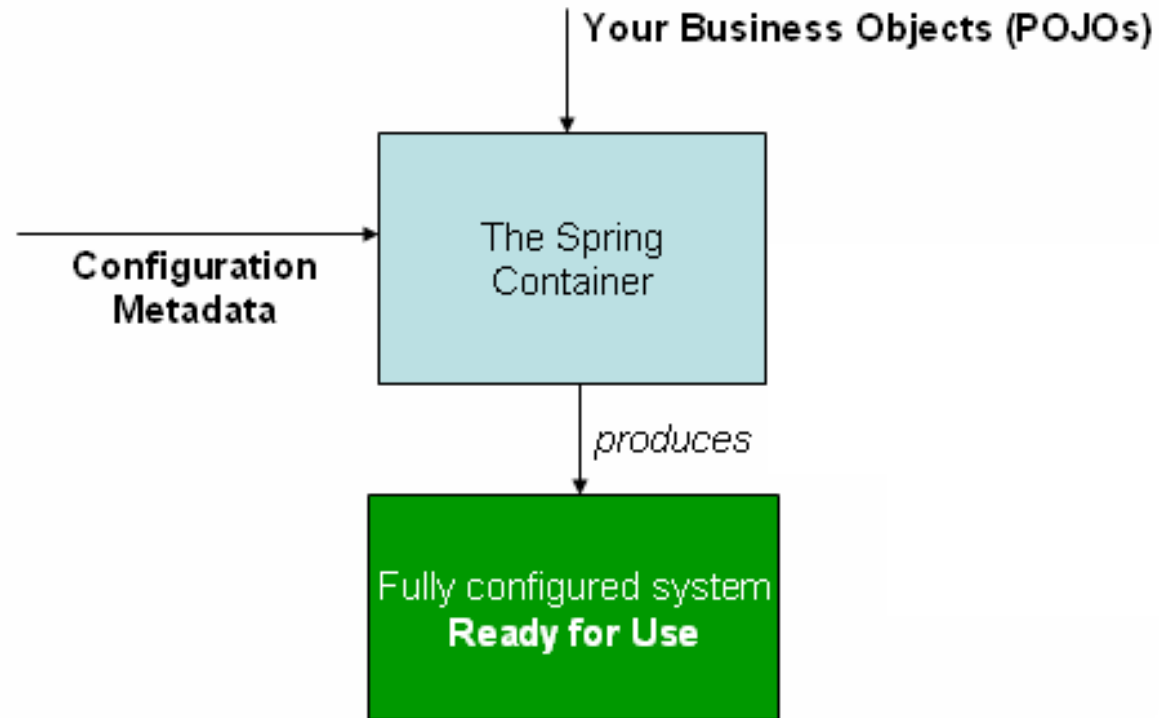
- Dependency Injection (DI) is a design pattern in which an object's dependency is injected by the framework rather than by the object itself
- The advantages of DI
 - Loosely coupled architecture.
 - Separation of responsibility.
 - Configuration and code are separate.
 - Improves testability.



Spring Bean

Beans

- A bean is an object that is instantiated, assembled, and otherwise managed by a Spring IoC container.



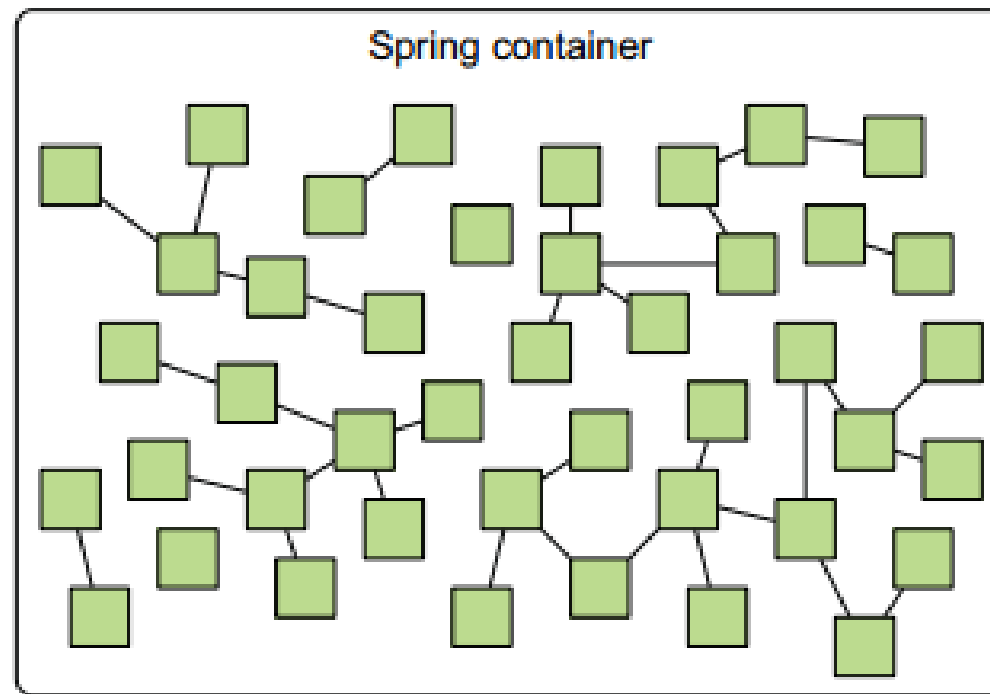


Spring Bean Configuration

- There are following three important methods to provide configuration metadata to the Spring Container
 - XML based configuration file
 - Annotation-based configuration
 - Java-based configuration

Spring Container

- In a Spring application, objects are created, are wired together, and live in the Spring container.





Spring Container

- Spring comes with several container implementations that can be categorized into two distinct types
 - Bean factories
 - Application contexts



Working with an application context

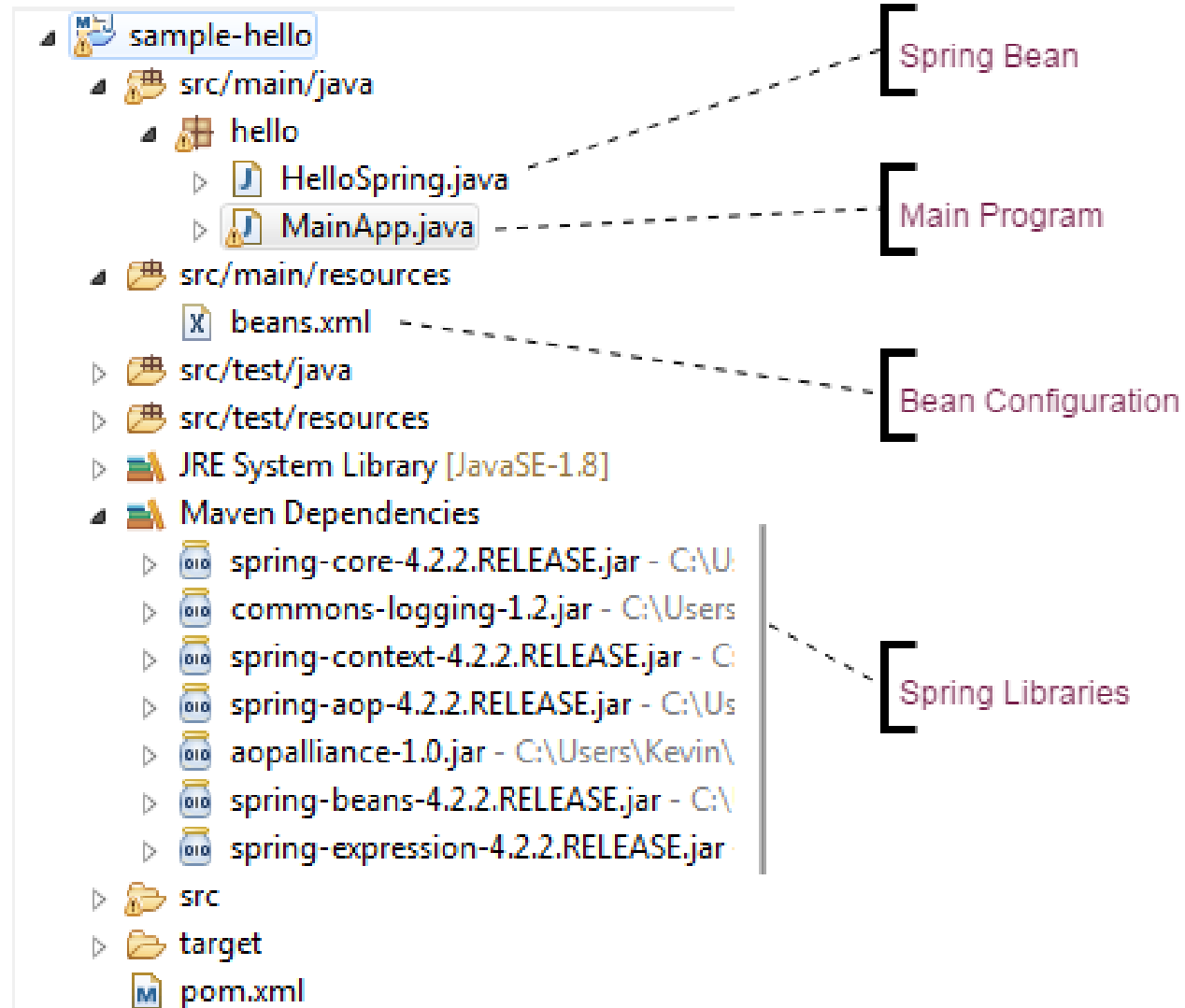
- **AnnotationConfigApplicationContext:** Loads a Spring application context from one or more Java-based configuration classes
- **ClassPathXmlApplicationContext:** Loads a context definition from one or more XML files located in the classpath
- **FileSystemXmlApplicationContext:** Loads a context definition from one or more XML files in the filesystem



Working with an application context

- **AnnotationConfigWebApplicationContext:** Loads a Spring web application context from one or more Java-based configuration classes
- **XmlWebApplicationContext:** Loads context definitions from one or more XML files contained in a web application

Sample Spring Application



Sample Spring Application

- Required Libraries

```
<dependencies>
  <dependency>
    <groupId>org.springframework</groupId>
    <artifactId>spring-core</artifactId>
    <version>4.2.2.RELEASE</version>
  </dependency>

  <dependency>
    <groupId>org.springframework</groupId>
    <artifactId>spring-context</artifactId>
    <version>4.2.2.RELEASE</version>
  </dependency>

</dependencies>
```


Sample Spring Application

- POJO – Spring Bean

```
public class HelloSpring {  
  
    private String message;  
  
    public String getMessage() {  
        return "Your message: " + message;  
    }  
  
    public void setMessage(String message) {  
        this.message = message;  
    }  
}
```

Sample Spring Application

- Bean Configuration

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

  <!-- bean definitions here -->

  <bean id="hello" class="hello.HelloSpring">
    <property name="message" value="Hello Spring 4!"/>
  </bean>

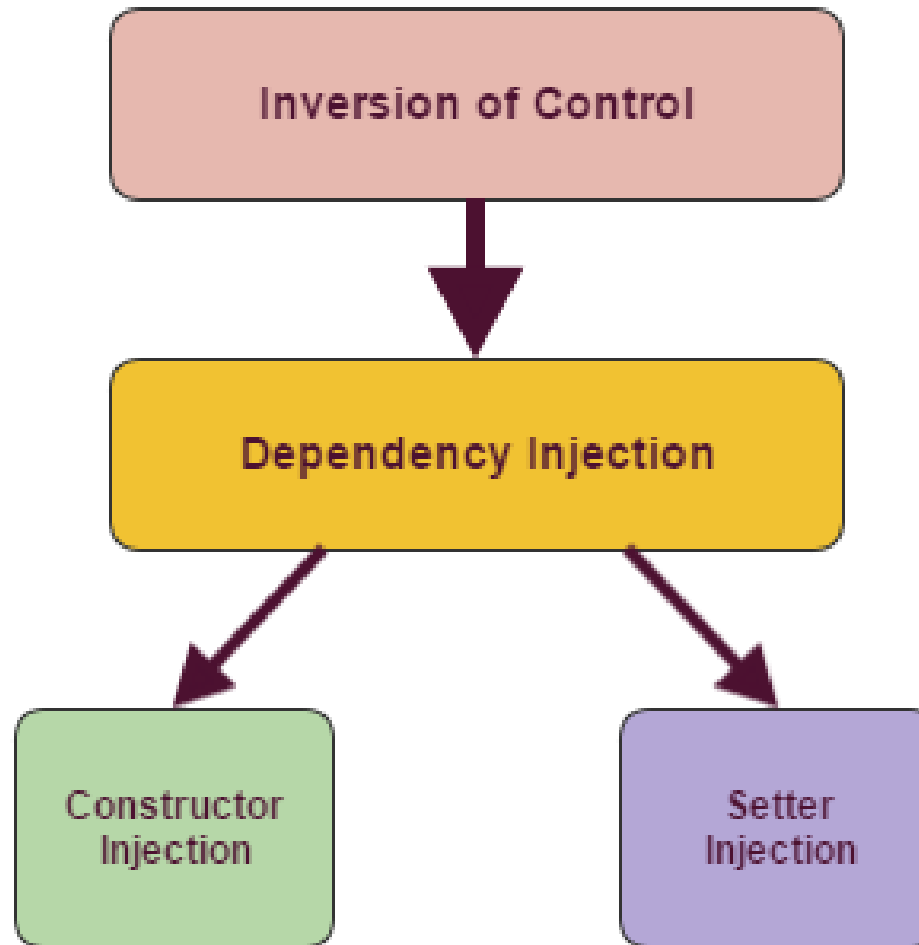
</beans>
```

Sample Spring Application

- Main Program

```
public static void main(String[] args) {  
    ApplicationContext context = new ClassPathXmlApplicationContext("beans.xml");  
  
    HelloSpring obj = (HelloSpring) context.getBean("hello");  
  
    System.out.println(obj.getMessage());  
  
}
```

Dependency Injection in Spring



Spring Constructor-based Dependency Injection

- The process of injecting the dependencies of an object through its constructor argument at the time of instantiating it.

```
public class ReportGenerator {  
    private PDFWriter pdfWriter;  
    public ReportGenerator(PDFWriter pdfWriter) {  
        this.pdfWriter = pdfWriter;  
    }  
}
```

```
<bean id="pdfWriter" class="constructor_injection.PDFWriter">  
</bean>
```

```
<bean id="reportGenerator" class="constructor_injection.ReportGenerator">  
    <constructor-arg ref="pdfWriter"/>  
</bean>
```

Spring Setter-based Dependency Injection

- The method of injecting the dependencies of an object using the setter method

```
public class ReportGenerator {  
    private PDFWriter pdfWriter;  
  
    public PDFWriter getPdfWriter() {  
        return pdfWriter;  
    }  
  
    public void setPdfWriter(PDFWriter pdfWriter) {  
        this.pdfWriter = pdfWriter;  
    }  
}
```

```
<!-- bean definitions here -->
```

```
<bean id="pdfWriter" class="setter_injection.PDFWriter">  
</bean>
```

```
<bean id="reportGenerator" class="setter_injection.ReportGenerator">  
    <property name="pdfWriter" ref="pdfWriter"/>  
</bean>
```

Injecting inner beans

- Similar to the concept of inner classes in Java, it is also possible to define a bean inside another bean

```
public class ATM {
    private Printer printer;

    public Printer getPrinter() {
        return printer;
    }

    public void setPrinter(Printer printer) {
        this.printer = printer;
    }
}

<!-- bean definitions here -->

<bean id="atmBean" class="inner_bean.ATM">
    <property name="printer">
        <bean class="inner_bean.Printer">
            <property name="message"
                value="The balance information is printed by Printer for the account number">
            </property>
        </bean>
    </property>
</bean>
```

Injecting primary data types

```
<bean id="exampleBean" class="examples.ExampleBean">
  <constructor-arg type="int" value="7500000"/>
  <constructor-arg type="java.lang.String" value="42"/>
</bean>
```

```
<bean id="dateFormat" class="java.text.SimpleDateFormat">
  <constructor-arg value="yyyy-MM-dd" />
</bean>

<bean id="customer" class="com.mkyong.common.Customer">
  <property name="date">
    <bean factory-bean="dateFormat" factory-method="parse">
      <constructor-arg value="2010-01-31" />
    </bean>
  </property>
</bean>
```


Injecting Collection

| Element | Description |
|---------|--|
| <list> | This helps in wiring ie injecting a list of values, allowing duplicates. |
| <set> | This helps in wiring a set of values but without any duplicates. |
| <map> | This can be used to inject a collection of name-value pairs where name and value can be of any type. |
| <props> | This can be used to inject a collection of name-value pairs where the name and value are both Strings. |

Injecting Collection

- List

```
<!-- results in a setAddressList(java.util.List) call -->  
<property name="addressList">  
  <list>  
    <value>INDIA</value>  
    <value>Pakistan</value>  
    <value>USA</value>  
    <value>USA</value>  
  </list>  
</property>
```

- Set

```
<!-- results in a setAddressSet(java.util.Set) call -->  
<property name="addressSet">  
  <set>  
    <value>INDIA</value>  
    <value>Pakistan</value>  
    <value>USA</value>  
    <value>USA</value>  
  </set>  
</property>
```

Injecting Collection

- Map

```
<!-- results in a setAddressMap(java.util.Map) call -->
<property name="addressMap">
  <map>
    <entry key="1" value="INDIA"/>
    <entry key="2" value="Pakistan"/>
    <entry key="3" value="USA"/>
    <entry key="4" value="USA"/>
  </map>
</property>
```

- Props

```
<!-- results in a setAddressProp(java.util.Properties) call -->
<property name="addressProp">
  <props>
    <prop key="one">INDIA</prop>
    <prop key="two">Pakistan</prop>
    <prop key="three">USA</prop>
    <prop key="four">USA</prop>
  </props>
</property>
```



Autowiring in Spring

- Spring container can automatically autowire relationships between collaborating beans by inspecting the contents of BeanFactory
- Autowiring helps us reduce some of these configurations by intelligently guessing what the reference is.
- Spring wires a bean's properties automatically by setting the autowire property on each <bean> tag that you want to autowire.

Autowiring modes

| Mode | Description |
|-------------|--|
| No | By default, Spring bean autowiring is turned off, that is, no autowiring is to be performed, and you should use explicit bean reference <code>ref</code> for wiring. |
| byname | This is autowiring by property name, that is, if the bean property is the same as the other bean name, autowire it. The setter method is used for this type of autowiring to inject a dependency. |
| byType | The data type is used for this type of autowiring. If the data type bean property is compatible with the data type of the other bean, autowire it. Only one bean should be configured for this type in the configuration file; otherwise, a fatal exception is thrown. |
| constructor | This is similar to autowire <code>byType</code> , but here the constructor is used to inject a dependency. |
| autodetect | Spring first tries to autowire by the constructor; if it does not work, then Spring tries to autowire with <code>byType</code> . This option is deprecated. |

Spring Autowiring 'byName'

```
public class ATM {  
    private Printer printer;  
  
    public Printer getPrinter() {  
        return printer;  
    }  
  
    public void setPrinter(Printer printer) {  
        this.printer = printer;  
    }  
}
```

```
<!-- bean definitions here -->  
<bean id="printer" class="autowire_byname.Printer">  
    <property name="message"  
        value="The balance information is printed by Printer for the account number">  
    </property>  
</bean>  
  
<bean id="atmBean" class="autowire_byname.ATM" autowire="byName">  
</bean>
```

Spring Autowiring 'byType'

```
<!-- bean definitions here -->
<bean id="printer" class="autowire_bytype.Printer">
    <property name="message"
        value="The balance information is printed by Printer for the account number">
    </property>
</bean>

<bean id="atmBean" class="autowire_bytype.ATM" autowire="byType">
</bean>
```

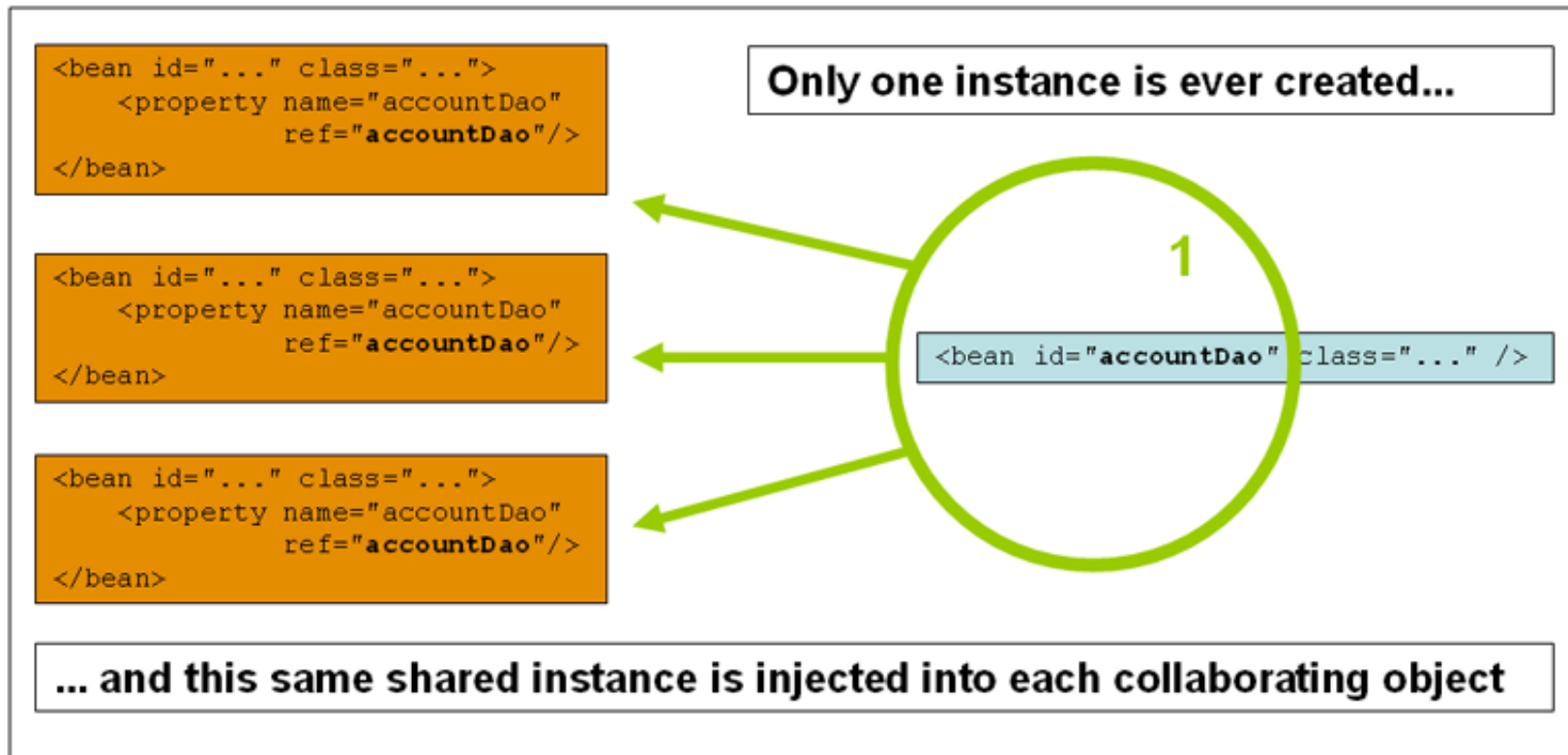
Spring Autowiring by Constructor

```
public class ATM {  
  
    private Printer printer;  
  
    public ATM(Printer printer) {  
        this.printer = printer;  
    }  
  
    <!-- bean definitions here -->  
    <bean id="printer" class="autowire_byconstructor.Printer">  
        <property name="message"  
            value="The balance information is printed by Printer for the account number">  
        </property>  
    </bean>  
  
    <bean id="atmBean" class="autowire_byconstructor.ATM" autowire="constructor">  
    </bean>
```


Bean's Scope

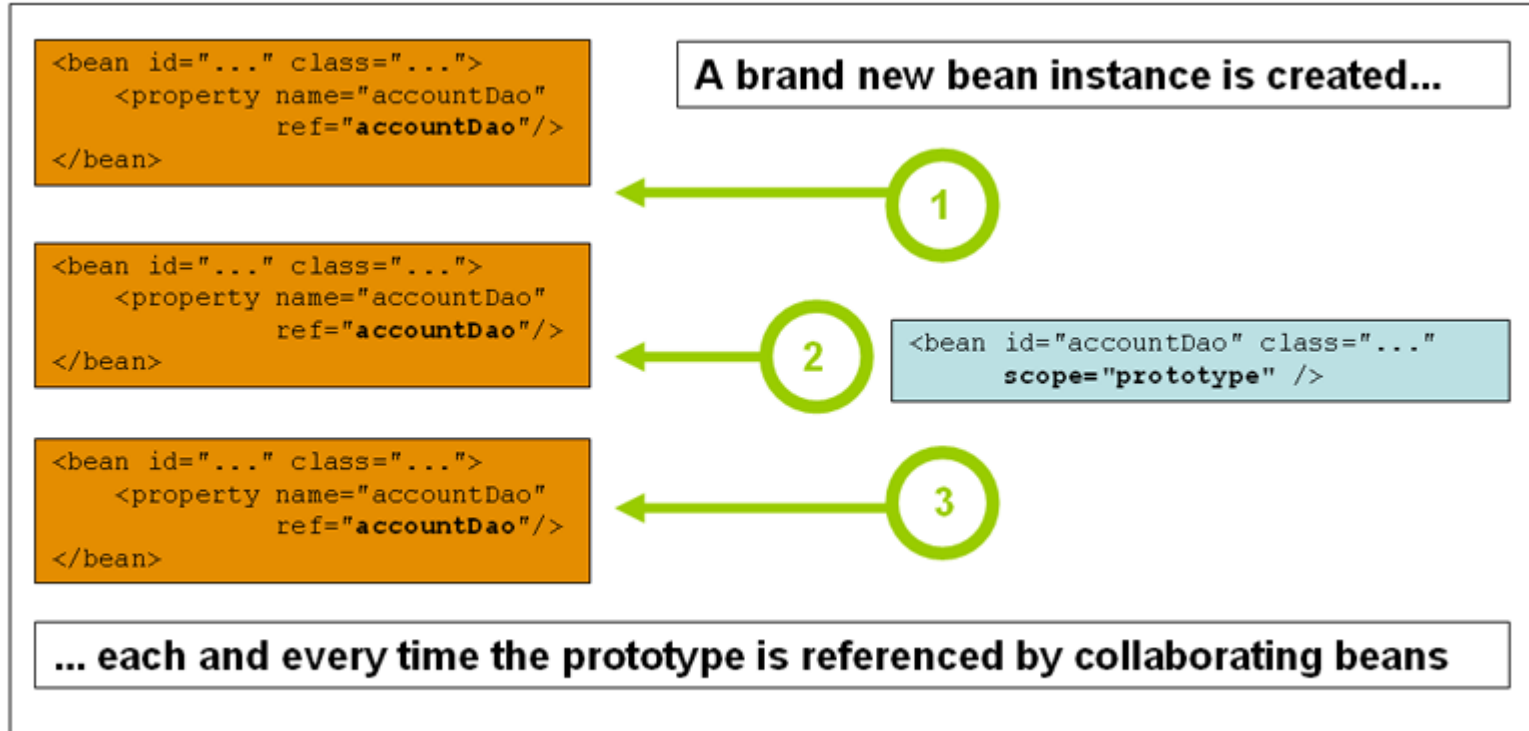
| Scope | Description |
|----------------|---|
| singleton | This scopes the bean definition to a single instance per Spring IoC container (default). |
| prototype | This scopes a single bean definition to have any number of object instances. |
| request | This scopes a bean definition to an HTTP request. Only valid in the context of a web-aware Spring ApplicationContext. |
| session | This scopes a bean definition to an HTTP session. Only valid in the context of a web-aware Spring ApplicationContext. |
| global-session | This scopes a bean definition to a global HTTP session. Only valid in the context of a web-aware Spring ApplicationContext. |

Singleton Scope



```
<!-- A bean definition with singleton scope -->
<bean id="..." class="..." scope="singleton">
  <!-- collaborators and configuration for this bean go here -->
</bean>
```

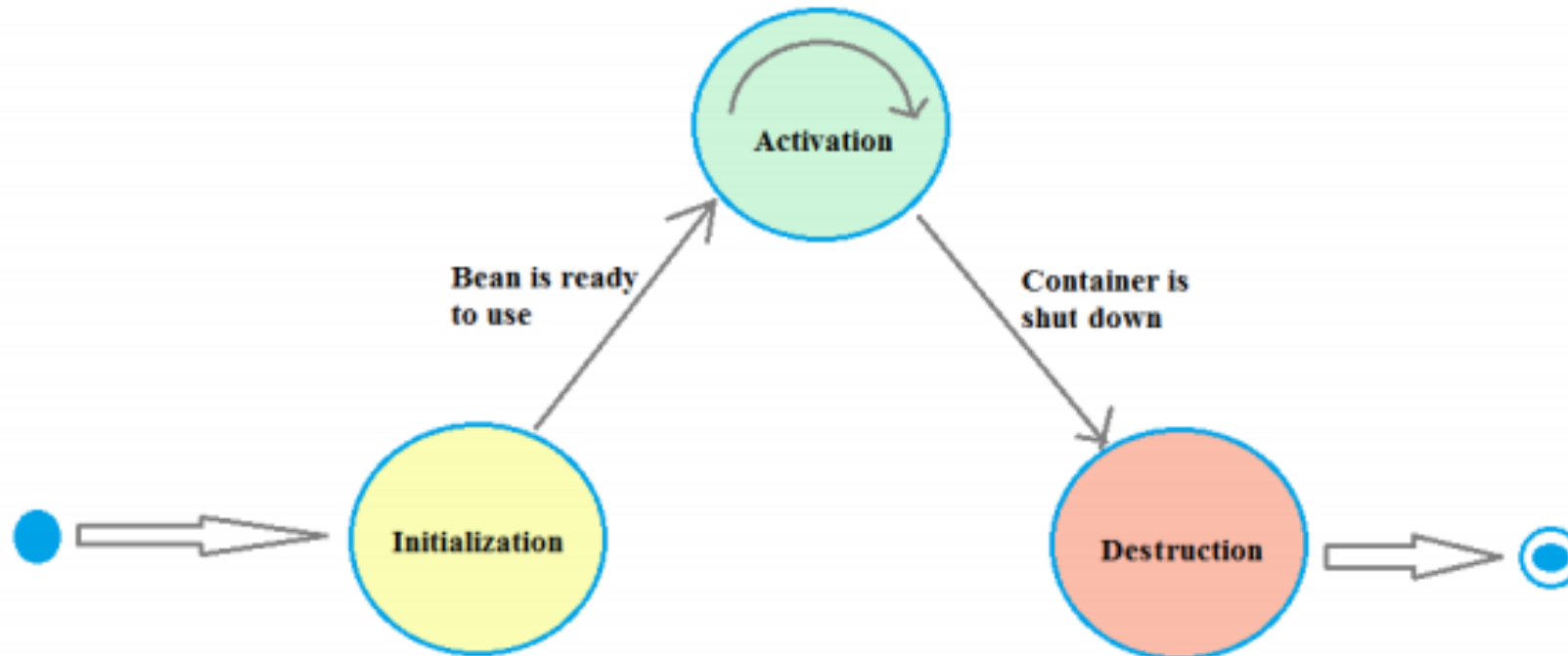
Prototype Scope



```
<!-- A bean definition with singleton scope -->
<bean id="..." class="..." scope="prototype">
  <!-- collaborators and configuration for this bean go here -->
</bean>
```

Life Cycle of Bean

- Post-initialization callback methods
- Pre-dest



Using Spring Annotations



Spring Stereotypes

- **@Component**
 - A generic stereotype that Spring will recognize as a Spring-managed component.
- **@Repository**
 - This is a specialization of the @Component annotation and it fulfills the idea of the data access object.
- **@Service**
 - This is a specialization of the @Component annotation and it fulfills the idea of a service layer.
- **@Controller**
 - This is also a specialization of the @Component annotation and normally is used on a web context.



@Autowired

- Spring container to actually create the instance and assign it to the declared variable
- The @Autowired annotation can be used to autowire bean on
 - Setter Methods
 - Properties
 - Constructors

@Autowired

- XML Configuration

```
<?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:context="http://www.springframework.org/schema/context"
  xsi:schemaLocation="
    http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/context
    http://www.springframework.org/schema/context/spring-context.xsd">
  <context:annotation-config/>
```


@Autowired on Setter Methods

```
import org.springframework.beans.factory.annotation.Autowired;

public class ATM {
    private Printer printer;

    public Printer getPrinter() {
        return printer;
    }

    @Autowired
    public void setPrinter(Printer printer) {
        this.printer = printer;
    }
}
```

```
<!-- bean definitions here -->
<bean id="printer" class="annotation_utowire_setter.Printer">
    <property name="message"
        value="The balance information is printed by Printer for the account number">
    </property>
</bean>

<bean id="atmBean" class="annotation_utowire_setter.ATM">
</bean>
```

@Autowired on Properties

```
import org.springframework.beans.factory.annotation.Autowired;

public class ATM {

    @Autowired
    private Printer printer;

    public Printer getPrinter() {
        return printer;
    }

    public void setPrinter(Printer printer) {
        this.printer = printer;
    }
}
```

@Autowired on Constructors

```
import org.springframework.beans.factory.annotation.Autowired;

public class ATM {

    private Printer printer;

    @Autowired
    public ATM(Printer printer) {
        this.printer = printer;
    }
}
```

Points to Remember

Questions & Answer



Thank You!

Revision History

| Date | Version | Description | Updated by | Reviewed and Approved By |
|------------|---------|------------------|------------|--------------------------|
| 12/05/2015 | 1.0 | Initial Document | Kien Tran | |
| | | | | |
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