

1 Sources

- <https://redips789.github.io/spring-certification/Spring-Certification.html>
- <https://www.baeldung.com/inversion-control-and-dependency-injection-in-spring>
- <https://www.baeldung.com/inversion-control-and-dependency-injection-in-spring>
- <https://www.baeldung.com/spring-bean-names>
- <https://www.baeldung.com/spring-core-annotations>
- <https://www.baeldung.com/spring-bean-annotations>
- <https://www.baeldung.com/spring-component-scanning>
- <https://www.baeldung.com/spring-annotations-resource-inject-autowire>
- <https://www.digitalocean.com/community/tutorials/spring-bean-life-cycle>

TBD <https://www.baeldung.com/spring-annotations-resource-inject-autowire>

2 Bean Lifecycle

2.1 Overview

From a bird's eye, everything that happens before a bean is ready to use can be assigned to one of three phases (see fig. 1):

- Loading and maybe modifying bean definitions
- Instantiating beans
- Initializing beans

Figure 2 focuses on pre-initialization.

On the other hand, fig. 4 zooms in on post-instantiation.

See <https://www.digitalocean.com/community/tutorials/spring-bean-life-cycle> for code to display the order of invocations.

2.1.1 Load bean definitions, creating an ordered graph

In this step, all the configuration files – @Configuration classes or XML files – are processed. For annotation-based configuration, all the classes annotated with @Components are scanned to load the bean definitions.

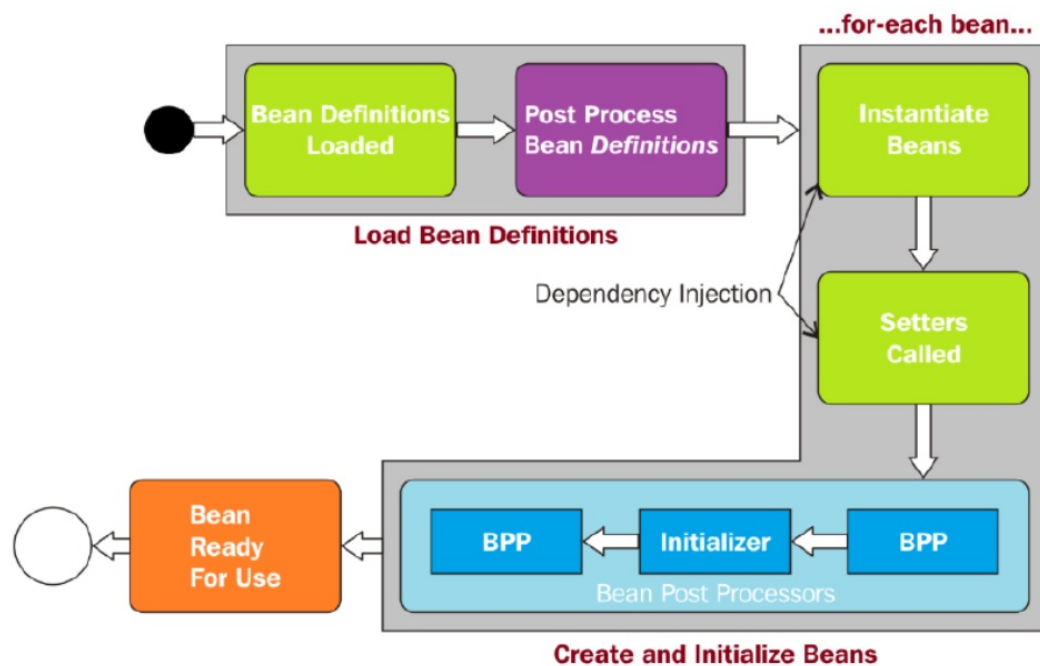


Figure 1: Lifecycle overview

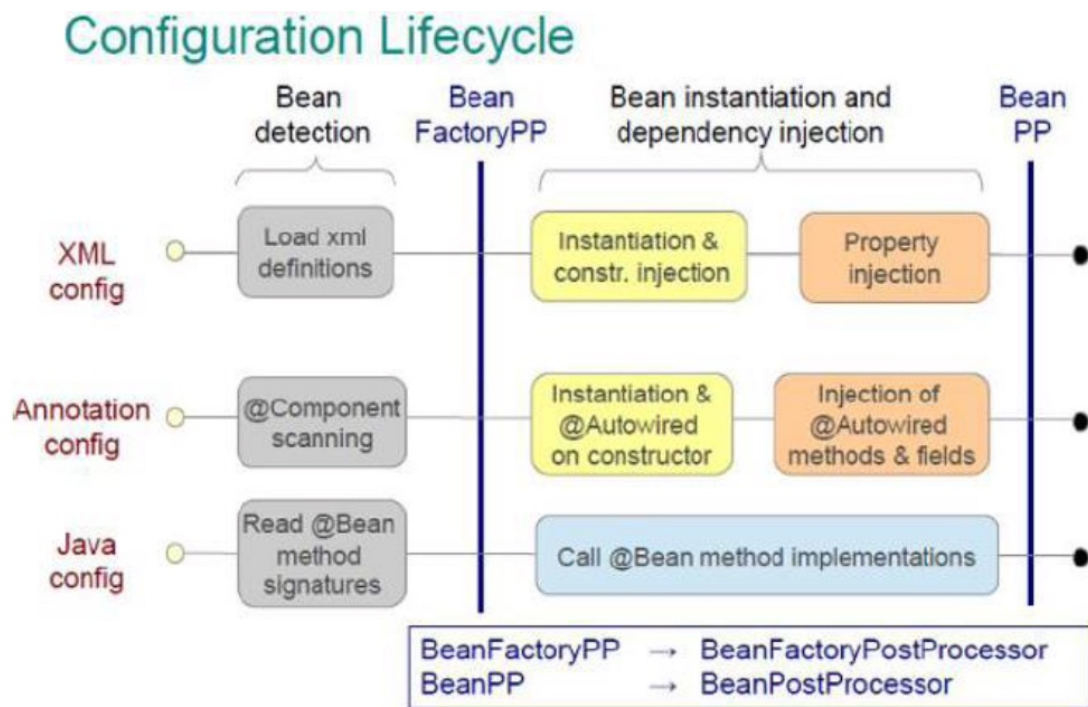


Figure 2: Zooming in on pre-instantiation

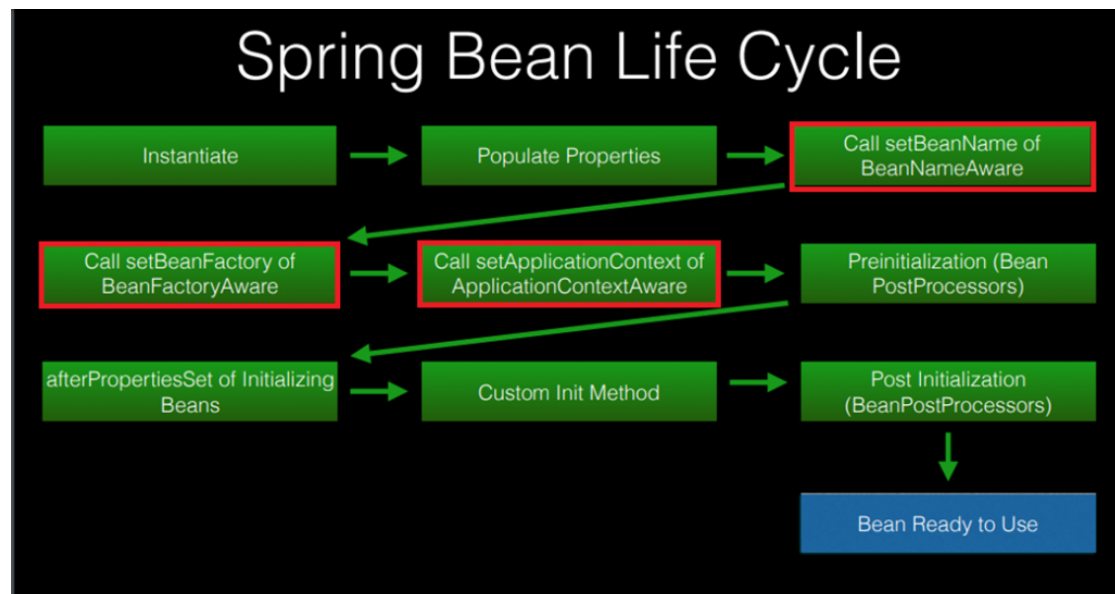


Figure 3: Zooming in on post-instantiation

2.1.2 Instantiate and run BeanFactoryPostProcessors

In a Spring application, a BeanFactoryPostProcessor can modify the definition of any bean. The BeanFactory object is passed as an argument to the postProcess() method of the BeanFactoryPostProcessor. BeanFactoryPostProcessor then works on the bean definitions or the configuration metadata of the bean before the beans are actually created. Spring provides several useful implementations of BeanFactoryPostProcessor, such as reading properties and registering a custom scope. We can write your own implementation of the BeanFactoryPostProcessor interface. To influence the order in which bean factory post processors are invoked, their bean definition methods may be annotated with the @Order annotation. If you are implementing your own bean factory post processor, the implementation class can also implement the Ordered interface.

2.1.3 Instantiate beans

Injects values and bean references into beans' properties.

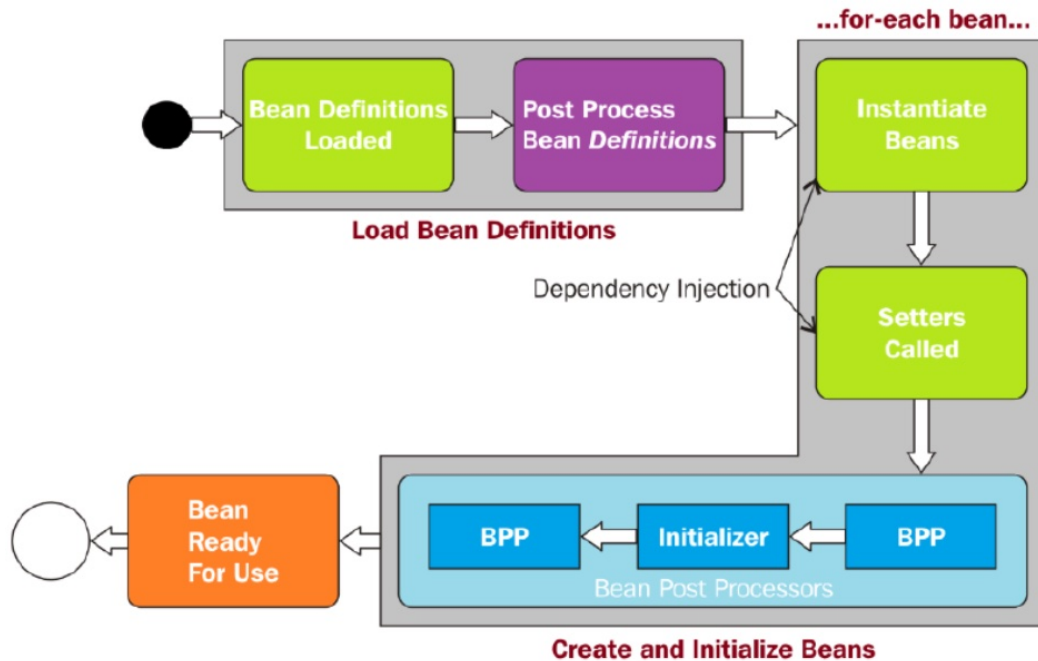


Figure 4:

- 2.1.4 Call `BeanNameAware`'s `setBeanName()` for each bean implementing it
- 2.1.5 Call `BeanFactoryAware`'s `setBeanFactory()` passing the bean factory for each bean implementing it
- 2.1.6 Call `ApplicationContextAware`'s `setApplicationContext` for each bean implementing it
- 2.1.7 Run pre-initialization `BeanPostProcessors`

The Application context calls `postProcessBeforeInitialization()` for each bean implementing `BeanPostProcessor`. A bean implementing `BeanFactoryPostProcessor` is called when all bean definitions have been loaded, but no beans will have been instantiated yet. This allows for overriding or adding properties even to eager-initializing beans. This will let you have access to all the beans that you have defined in XML or that are annotated (scanned via component-scan).

2.1.8 Call `InitializingBean`'s `afterPropertiesSet()`

If a bean implements the `InitializingBean` interface, Spring calls its `afterPropertiesSet()` method. Used to initialize processes, load resources, etc. This approach is simple to use but it's not recommended because it will create tight coupling with the Spring framework in our bean implementations.

2.1.9 Init Method

Instead of implementing `InitializingBean`, you can use the `init-method` of the `bean` tag, the `initMethod` attribute of the `@Bean` annotation, and JSR 250's `@PostConstruct` annotation. Here we use the `init-method` attribute:

```
1 <bean name="myEmployeeService"
   class="com.journaldev.spring.service.MyEmployeeService"
2   init-method="init" destroy-method="destroy">
3   <property name="employee" ref="employee"></property>
4 </bean>
```

And here, the `@PostConstruct` annotation.

```
1 @PostConstruct
2 public void init() {
3     System.out.println("MyService init method called");
4 }
```

2.1.10 Run post-initialization `BeanPostProcessors`

The application context calls `postProcessAfterInitialization()` for each bean implementing `BeanPostProcessor`.

2.1.11 Bean ready to use

Your beans remain live in the application context until it is closed by calling the `close()` method of the application context.

2.1.12 Custom destruction

If a bean implements the `DisposableBean` interface, Spring calls its `destroy()` method to destroy any process or clean up the resources of your application. There are other methods to achieve this step-for example, you can use the `destroy-method` of the tag, the `destroyMethod` attribute of the `@Bean` annotation, and JSR 250's `@PreDestroy` annotation.

3 Dependency injection

3.1 Constructor-based

In the case of constructor-based dependency injection, the container will invoke a constructor with arguments each representing a dependency we want to set. This is the recommended way.

```

1      @Configuration
2      public class AppConfig {
3          @Bean
4          public Item item1() {
5              return new ItemImpl1();
6          }
7          @Bean
8          public Store store() {
9              return new Store(item1());
10         }
11     }

```

Resp.

```

1      <bean id="item1" class="org.baeldung.store.ItemImpl1"
2          />
3      <bean id="store" class="org.baeldung.store.Store">
4          <constructor-arg type="ItemImpl1" index="0"
5              name="item" ref="item1" />
6      </bean>

```

3.2 Method-based

For setter-based DI, the container will call setter methods of our class after invoking a no-argument constructor or no-argument static factory method to instantiate the bean.

```

1      @Bean
2      public Store store() {
3          Store store = new Store();
4          store.setItem(item1());
5          return store;
6      }

```

Resp.

```

1      <bean id="store" class="org.baeldung.store.Store">
2          <property name="item" ref="item1" />
3      </bean>

```

3.3 Field-based

In field-based DI, we can inject the dependencies by marking them with an `@Autowired` annotation. (This even works for private fields.) Field-based injection is not recommended - e.g., it makes testing harder.

```
1      public class Store {
2          @Autowired // deprecated
3          private Item item;
4      }
```

4 Configuration: Implicit vs. Explicit

Also referred to as Java-based (decoupled) and annotation-based.

4.1 Java-based

Takes place completely in `@Configuration` classes. E.g.,

```
1      @Configuration
2      public class MyConfig {
3          @Bean
4          public AccountRepo AccountRepo() {}
5      }
```

4.2 Java-based

Bean definition and wiring take place completely in POJOs. For this to work, we need to enable component scanning.

```
1      @Configuration
2      @ComponentScan
3      public class MyConfig {}
4
5      @Component
6      public class AccountRepo {}
```

5 Annotations

5.1 Annotations for dependency injection

5.1.1 @Autowired

@Autowired marks a dependency which Spring is going to resolve and inject. We can use this annotation with constructor, setter, or field injection. E.g.,

```
1      class Car {
2          @Autowired
3          Engine engine;
4      }
```

Starting with version 4.3, we don't need to annotate constructors with @Autowired explicitly unless we declare at least two constructors.

@Autowired matches by type. If there are several classes matching the required type (e.g., implementing the same interface), @Autowired needs to be supplemented by @Qualifier:

```
1      @Component("Repo1")
2      class Repo1 implements Repo {}
3
4      @Component("Repo2")
5      class Repo2 implements Repo {}
6
7      @Component
8      public class Service1 implements ServiceX {
9          public Service1(@Qualifier("Repo2") Repo) {}
10
11     }
```

If there is no @Qualifier given, @Autowired looks for a matching bean name (= bean id). Here, Spring will look for a bean named x:

```
1      // constructor injection
2      @Autowired
3      public MyBean(X x) {}
4
5      // method injection
6      @Autowired
7      public setX(X x) {}
8
9      // field injection
10     @Autowired
```



```
11     private X x;
```

5.1.2 @Bean

@Bean marks a factory method which instantiates a Spring bean.

```
1     @Bean
2     Engine engine() {
3         return new Engine();
4     }
```

Spring calls these methods when a new instance of the return type is required. All methods annotated with @Bean must be in @Configuration classes.

5.1.3 @Resource

The @Resource annotation matches by name, type, or qualifier (in this order). It is applicable to setter and field injection. Here's an example injecting a field. Note that the bean id and the corresponding reference attribute value must match:

```
1     @Configuration
2     public class MyAppContext {
3         @Bean(name="namedFile")
4         public File namedFile() {
5             File namedFile = new File("namedFile.txt");
6             return namedFile;
7         }
8     }
9
10    @ContextConfiguration(
11        loader=AnnotationConfigContextLoader.class,
12        classes= MyAppContext.class)
13    public class Xxx {
14        @Resource(name="namedFile")
15        private File defaultFile;
16    }
```

5.1.4 @Inject

The @Inject annotation matches by type, qualifier, or name (in this order). It is applicable to setter and field injection. With @Inject, the class reference variable's name and the bean name don't have to match.

To use the `@Inject` annotation, declare the `javax.inject` library as a Gradle or Maven dependency.

```
1  public class MyAppContext {
2      @Bean
3      // no bean name specified – method name is used
4      public File getSomeFile() {
5          File namedFile = new File("namedFile.txt");
6          return namedFile;
7      }
8  }
9
10 @ContextConfiguration(
11     loader=AnnotationConfigContextLoader.class,
12     classes= MyAppContext.class)
13 public class Xxx {
14     @Inject
15     private File defaultFile;
16 }
```

5.1.5 @Value

We can use `@Value` for injecting property values into beans. It's compatible with constructor, setter, and field injection. E.g.,

```
1  Engine(@Value("8") int cylinderCount) {
2      this.cylinderCount = cylinderCount;
3  }
```

This is an alternative to making explicit use of Spring's `Environment` bean. E.g.

```
1  public DataSource dataSource(
2      @Value("${db.driver}") String driver,
3      ...
4  )
5  }
```

5.1.6 @DependsOn

We can use this annotation to make Spring initialize other beans before the annotated one. Usually, this behavior is automatic, based on the explicit dependencies between

beans. We only need this annotation when the dependencies are implicit, for example, JDBC driver loading or static variable initialization. E.g.,

```
1      @Bean
2      @DependsOn("fuel")
3      Engine engine() {
4          return new Engine();
5      }
```

5.1.7 @Lazy

This annotation behaves differently depending on where exactly we place it.

- In an @Bean-annotated bean factory method, it is used to delay the method call (hence the bean creation)
- With an @Configuration class, all contained @Bean methods will be affected
- For all other @Component classes, they will be initialized lazily when so annotated.
- @Autowired constructors, setters, and fields will be loaded lazily (via proxy).

```
1      @Configuration
2      @Lazy
3      class VehicleFactoryConfig {
4
5          @Bean
6          @Lazy(false)
7          Engine engine() {
8              return new Engine();
9          }
10     }
```

5.1.8 @Scope

@Scope is used to define the scope of a @Component class or a @Bean definition. It can be either singleton, prototype, request, session, globalSession or some custom @Component.

5.2 Context Configuration Annotations

5.2.1 @Import

With @import, we can use specific @Configuration classes without component scanning.

```

1      @Import( VehiclePartSupplier.class )
2      class VehicleFactoryConfig {}

```

5.2.2 @ImportResource

We can import XML configurations with @ImportResource. We can specify the XML file locations with the locations argument, or with its alias, the value argument:

```

1      @Configuration
2      @ImportResource("classpath:/annotations.xml")
3      class VehicleFactoryConfig {}

```

5.2.3 @PropertySource

With this annotation, we define property files for application settings.

```

1      @Configuration
2      @PropertySource("classpath:/annotations.properties")
3      @PropertySource("classpath:/vehicle-factory.properties")
4      class VehicleFactoryConfig {}

```

These properties can be used by Spring's Environment bean, in addition to environment variables and Java system properties.

Allowed prefixes are classpath:, file:, and http:.

5.3 Bean annotations

5.3.1 @Profile

Profiles are a way to group bean definitions, for example:

- dev, test, prod environment
- jdbc, jpa [implementations]

The @Profile annotation may be used in any of the following ways:

- At class level in @Configuration classes.
- At class level in classes annotated with @Component or annotated with any other annotation that in turn is annotated with @Component.
- On methods annotated with the @Bean annotation.

To define alternative beans with different profile conditions, use distinct Java method names pointing to the same bean name via the `@Bean` name attribute:

```
1      @Bean("dataSource")
2      @Profile("development")
3      public DataSource standaloneDataSource() {
4
5      @Bean("dataSource")
6      @Profile("production")
7      public DataSource jndiDataSource() throws Exception {}
```

Spring uses two separate properties when determining which profiles are active, `spring.profiles.active` and `spring.profiles.default`:

- If `spring.profiles.active` is set, then its value determines which profiles are active.
- If `spring.profiles.active` isn't set, then Spring looks to `spring.profiles.default`.
- If neither `spring.profiles.active` nor `spring.profiles.default` is set, only those beans that aren't defined as being in a profile are created.

These properties can be set on the command line:

```
1      -Dspring.profiles.active=embedded.jpa
```

, programmatically:

```
1      System.setProperty("spring.profiles.active",
2                          "embedded.jpa");
```

, or via an annotation (`@ActiveProfiles`; integration tests only).

5.3.2 @ComponentScan

The `@ComponentScan` annotation is used together with `@Configuration`.

`@ComponentScan` can be used with and without arguments.

Without arguments, `@ComponentScan` tells Spring to scan the current package and all of its sub-packages.

With arguments, `@ComponentScan` tells which packages or classes to scan. E.g., specifying packages:

```
1      @Configuration
2      @ComponentScan(basePackages =
3                      "com.baeldung.annotations")
4      class VehicleFactoryConfig {}
```

Or else, specifying classes:

```
1 @Configuration
2 @ComponentScan(basePackageClasses =
3     VehicleFactoryConfig.class)
4 class VehicleFactoryConfig {}
```

We can specify multiple package names, using spaces, commas, or semicolons as a separator.

```
1 @ComponentScan(basePackages =
2     "com.baeldung.componentscan.springapp.animals;com.baeldung.compone
3 @ComponentScan(basePackages =
4     "com.baeldung.componentscan.springapp.animals ,com.baeldung.compone
5 @ComponentScan(basePackages =
6     "com.baeldung.componentscan.springapp.animals
7     com.baeldung.componentscan.springapp.flowers")
```

We could also apply a filter, choosing from a range of filter types. For example:

```
1 @ComponentScan(excludeFilters =
2 @ComponentScan.Filter(type=FilterType.REGEX,
3     pattern="com\\.baeldung\\.componentscan\\.springapp\\.flowers\\.\\.\\.")
```

Or:

```
1 @ComponentScan(excludeFilters =
2 @ComponentScan.Filter(type =
3     FilterType.ASSIGNABLE_TYPE, value = Rose.class))
```

5.3.3 @Component

@Component is a class-level annotation. During component scan, Spring automatically detects classes annotated with @Component.

```
1 @Component
2 class CarUtility {
3     // ...
4 }
```

@Repository, @Service, @Configuration, and @Controller are all meta-annotations of @Component. Spring also automatically picks them up during the component scanning process.

5.3.4 @Repository

```
1      @Repository
2      class VehicleRepository {
3          // ...
4      }
```

5.3.5 @Service

```
1      @Service
2      public class VehicleService {
3          // ...
4      }
```

5.3.6 @Controller

```
1      @Controller
2      public class VehicleController {
3          // ...
4      }
```

5.3.7 @Configuration

Configuration classes can contain bean definition methods annotated with @Bean.

```
1      @Configuration
2      class VehicleFactoryConfig {
3
4          @Bean
5          Engine engine() {
6              return new Engine();
7          }
8
9      }
```

5.4 Spring Boot Annotations

5.4.1 @SpringBootApplication

This is a combination of three annotations:

```
1      @Configuration
2      @EnableAutoConfiguration
3      @ComponentScan
```

6 Aware Interfaces

Indicates that the bean is eligible to be notified by the Spring container through the callback methods. A typical use case for `BeanNameAware` could be acquiring the bean name for logging or wiring purposes. For the `BeanFactoryAware` it could be the ability to use a spring bean from legacy code. In most cases, we should avoid using any of the Aware interfaces, unless we need them. Implementing these interfaces will couple the code to the Spring framework.

6.1 BeanNameAware

Makes the object aware of the bean name defined in the container.

```
1      public class MyBeanName implements BeanNameAware {
2          @Override
3          public void setBeanName(String beanName) {
4              System.out.println(beanName);
5          }
6      }
7      @Configuration
8      public class Config {
9          @Bean(name = "myCustomBeanName")
10         public MyBeanName getMyBeanName() {
11             return new MyBeanName();
12         }
13     }
14     AnnotationConfigApplicationContext context
15     = new AnnotationConfigApplicationContext(Config.class);
16     MyBeanName myBeanName = context.getBean(MyBeanName.class);
```


6.2 BeanFactoryAware

Provides access to the BeanFactory which created the object.

```
1      public class MyBeanFactory implements BeanFactoryAware
2      {
3          private BeanFactory beanFactory;
4          @Override
5          public void setBeanFactory(BeanFactory
6              beanFactory) throws BeansException {
7              this.beanFactory = beanFactory;
8          }
9          public void getMyBeanName() {
10             MyBeanName myBeanName =
11                 beanFactory.getBean(MyBeanName.class);
12             System.out.println(beanFactory.isSingleton("myCustomBeanName"));
13         }
14     }
15     MyBeanFactory myBeanFactory =
16         context.getBean(MyBeanFactory.class);
17     myBeanFactory.getMyBeanName();}
```

6.3 ApplicationContextAware

```
1      public class ApplicationContextAwareImpl implements
2          ApplicationContextAware {
3          @Override
4          public void
5              setApplicationContext(ApplicationContext
6                  applicationContext) throws BeansException {
7              User user = (User)
8                  applicationContext.getBean("user");
9              System.out.println("User Id: " +
10                  user.getUserId() + " User Name : " +
11                  user.getName());}}
```

7 Bean Naming

7.1 Default Bean Naming

7.1.1 Class-level

For an annotation used at the class level, Spring uses the class name and converts the first letter to lowercase. The same default naming strategy is applicable for all class-level annotations that are used to create a Spring bean, such as `@Component`, `@Service`, and `@Controller`.

```
1      @Service
2      public class LoggingService { // bean name =
3          loggingService
4      }
```

7.1.2 Method-level

When we use the `@Bean` annotation on a method, Spring uses the method name as a bean name.

```
1      @Configuration
2      public class AuditConfiguration {
3          @Bean
4          public AuditService audit() {
5              return new AuditService();
6          }
7      }
```

7.2 Custom naming

```
1      @Component("myBean")
2      public class MyCustomComponent {
3      }
```

Similar to `@Component("myBean")`, we can specify the name using other annotations such as `@Service("myService")`, `@Controller("myController")`, and `@Bean("myCustomBean")`.

7.3 Naming Beans With @Bean and @Qualifier

7.3.1 @Bean With Value

The @Bean annotation is applied at the method level, and by default, Spring uses the method name as a bean name. We can override this using the @Bean annotation.

```
1      @Configuration
2      public class MyConfiguration {
3          @Bean("beanComponent")
4          public MyCustomComponent myComponent() {
5              return new MyCustomComponent();
6          }
7      }
```

7.3.2 @Qualifier With Value

We can also use the @Qualifier annotation to name the bean.

```
1      @Component
2      @Qualifier("cat")
3      public class Cat implements Animal {
4          @Override
5          public String name() {
6              return "Cat";
7          }
8      }
9      @Component
10     @Qualifier("dog")
11     public class Dog implements Animal {
12         @Override
13         public String name() {
14             return "Dog";
15         }
16     }
17     @Service
18     public class PetShow {
19         private final Animal dog;
20         private final Animal cat;
21
22         public PetShow (@Qualifier("dog") Animal dog,
23                         @Qualifier("cat") Animal cat) {
24             this.dog = dog;
25             this.cat = cat;
26         }
27     }
```

```

25         }
26         public Animal getDog() {
27             return dog;
28         }
29         public Animal getCat() {
30             return cat;
31         }
32     }

```

8 Spring Expression Language vs. Property Evaluation

Expressions in @Value annotations are of two types:

- Expressions starting with \$. Such expressions reference a property name in the application's environment. These expressions are evaluated by the PropertySourcePlaceholderConfigurer Spring bean prior to bean creation and can only be used in @Value annotations.
- Expressions starting with #. These expressions are parsed by a SpEL expression parser, and are evaluated by a SpEL expression instance.

In some cases, both can be used. For example, property values by default are Strings, but may be converted to primitives implicitly. So, both of these work:

```

1     @Value("${daily.limit}")
2     int limit;
3
4     @Value("#{environment['daily.limit']}")
5     int limit;

```

But if computations are to be performed, or object types are required, SpEL has to be used:

```

1     // NO
2     @Value("${daily.limit} * 2")
3
4     // instead, do
5     @Value("#{new Integer(environment['daily.limit']) * 2}")

```

To provide defaults, use a colon with property evaluation, and ?: in SpEL.

```
1      @Value("${daily.limit}: 1000")
2      int limit;
3
4      @Value("#{environment['daily.limit']} ?: 1000")
5      int limit;
```

In addition to application-defined beans, SpEL can make use of beans implicitly provided by Spring, namely `environment`, `systemProperties`, and `systemEnvironment`.