CS544
Enterprise Application Architecture

Lesson 1 – Introduction

Frameworks and Best Practices Used in Designing Large-Scale Software Systems

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Original Material: Prof. Rene de Jong – July 2022

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December 5 **Lesson 7** Transactions	December 6 **Lesson 8** MongoDB	December 7 **Midterm Review**	December 8 **Midterm exam**	December 9 **Lesson 9** REST webservices	December 10 **Lesson 10** SOAP webservices	December 11
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Enterprise Application Architecture

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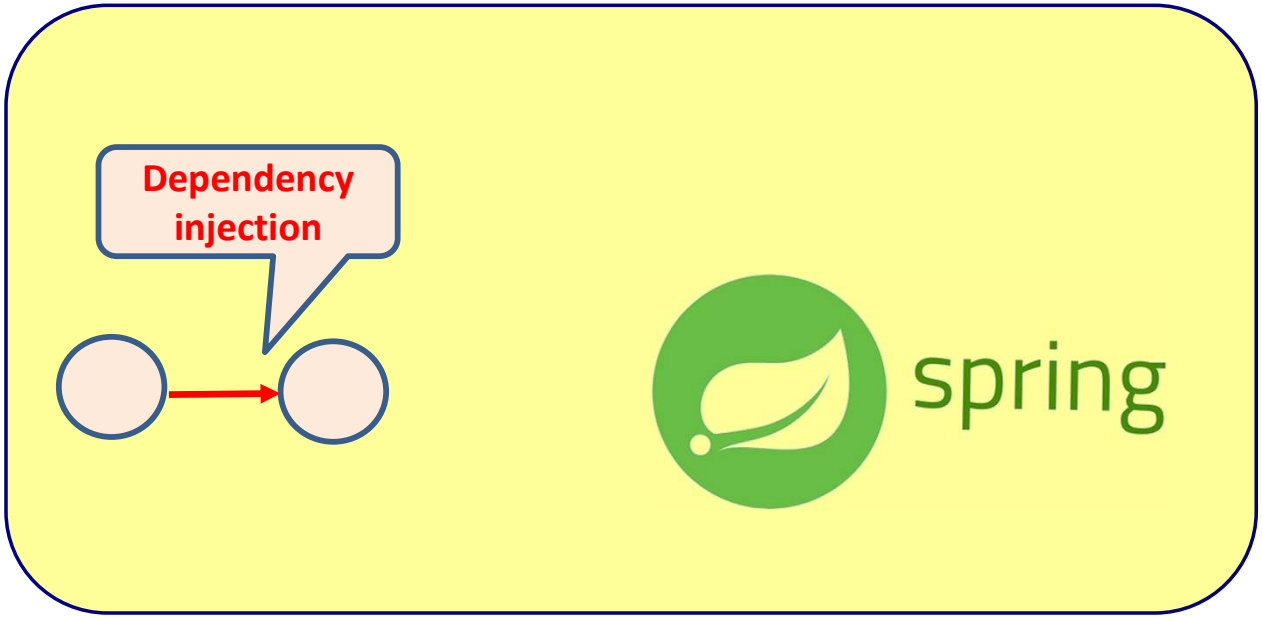
Lesson 1: Introduction to Spring



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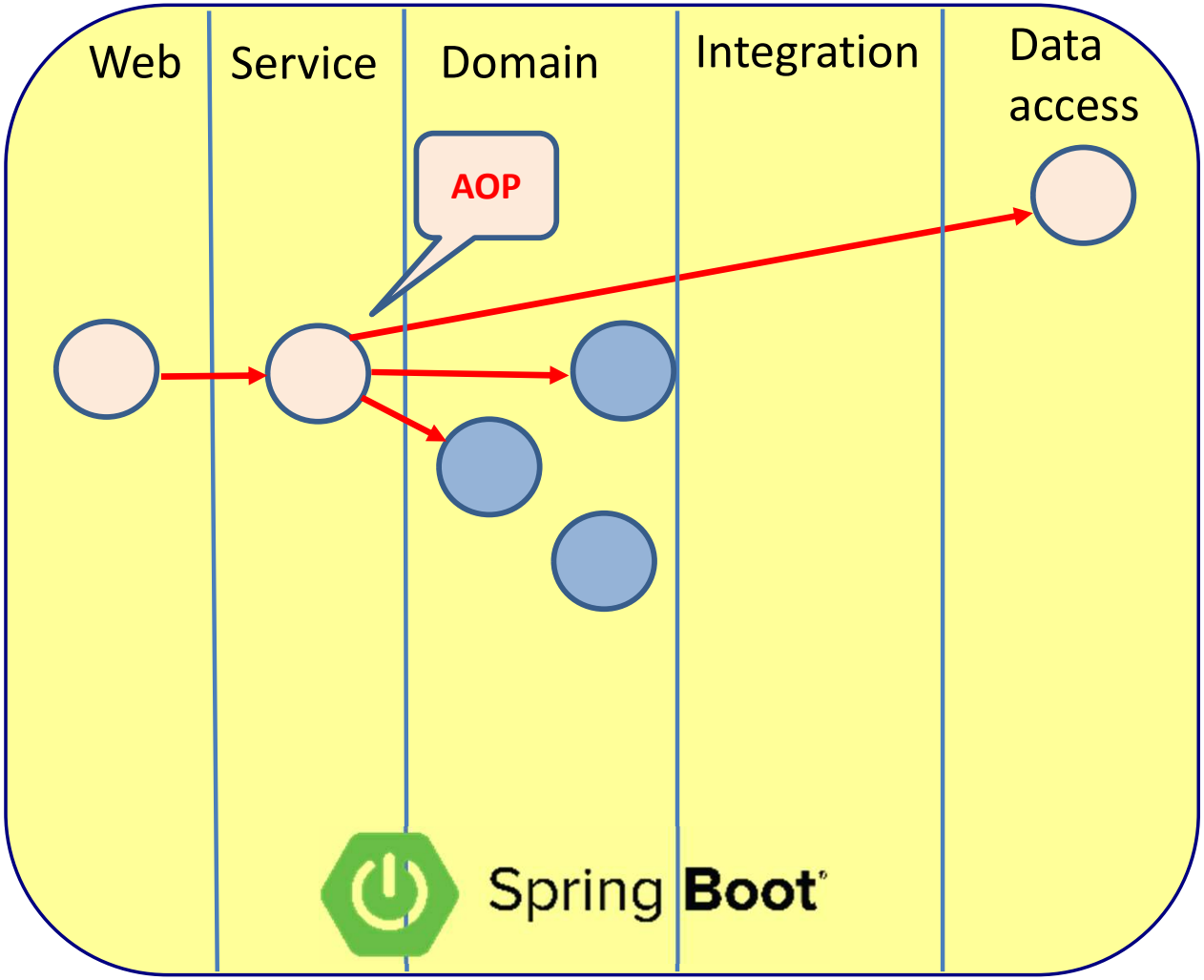

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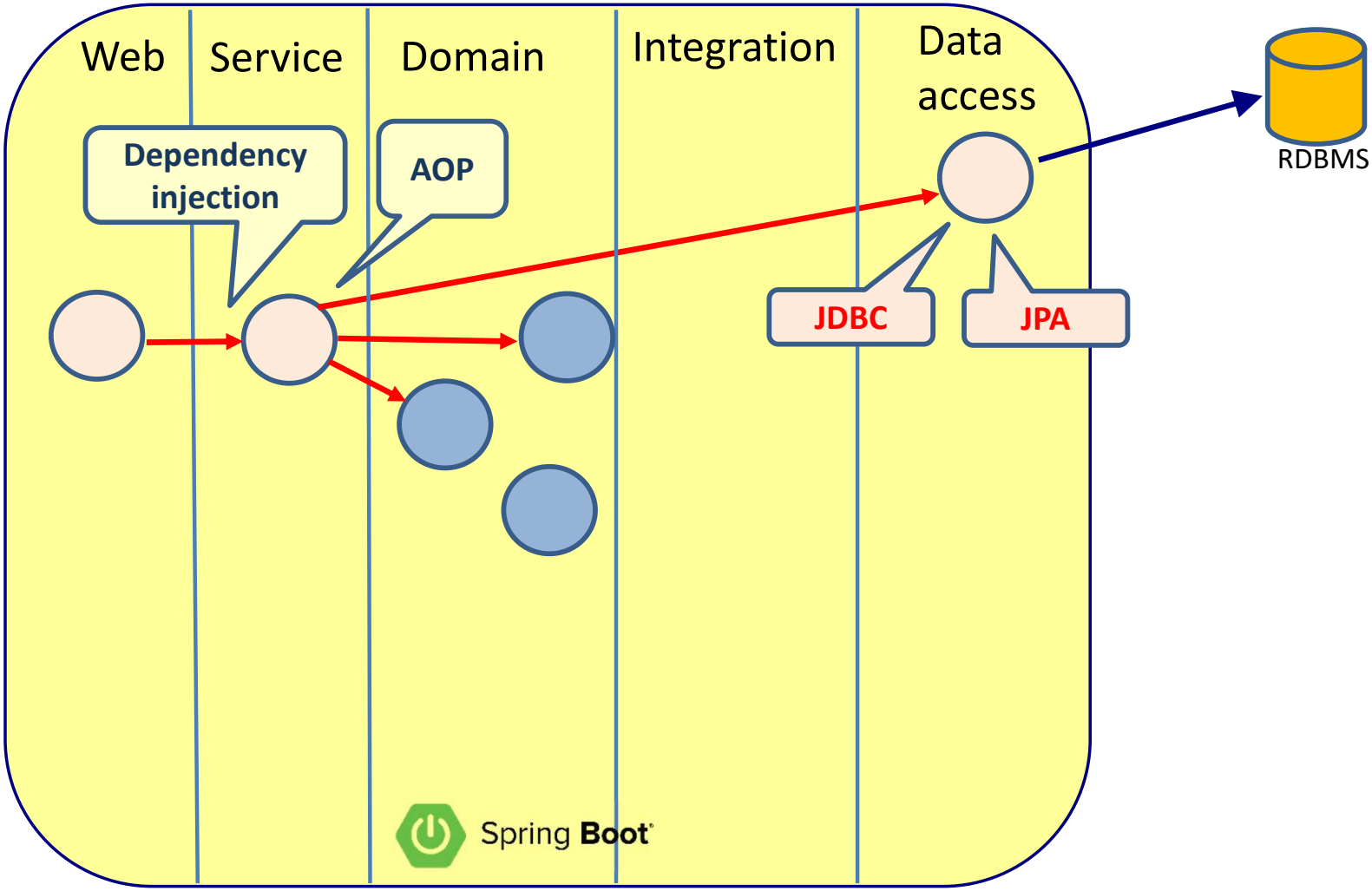

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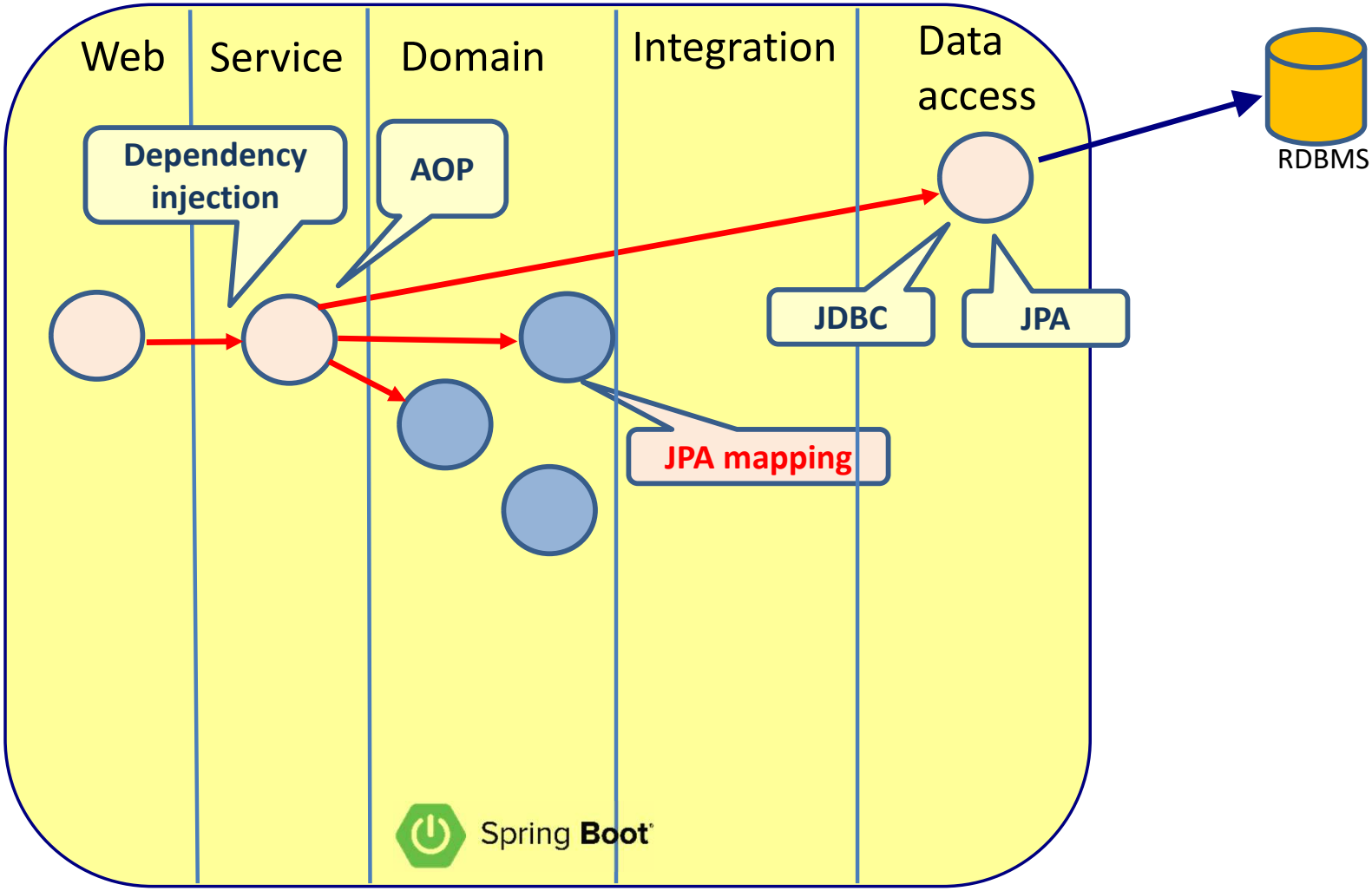

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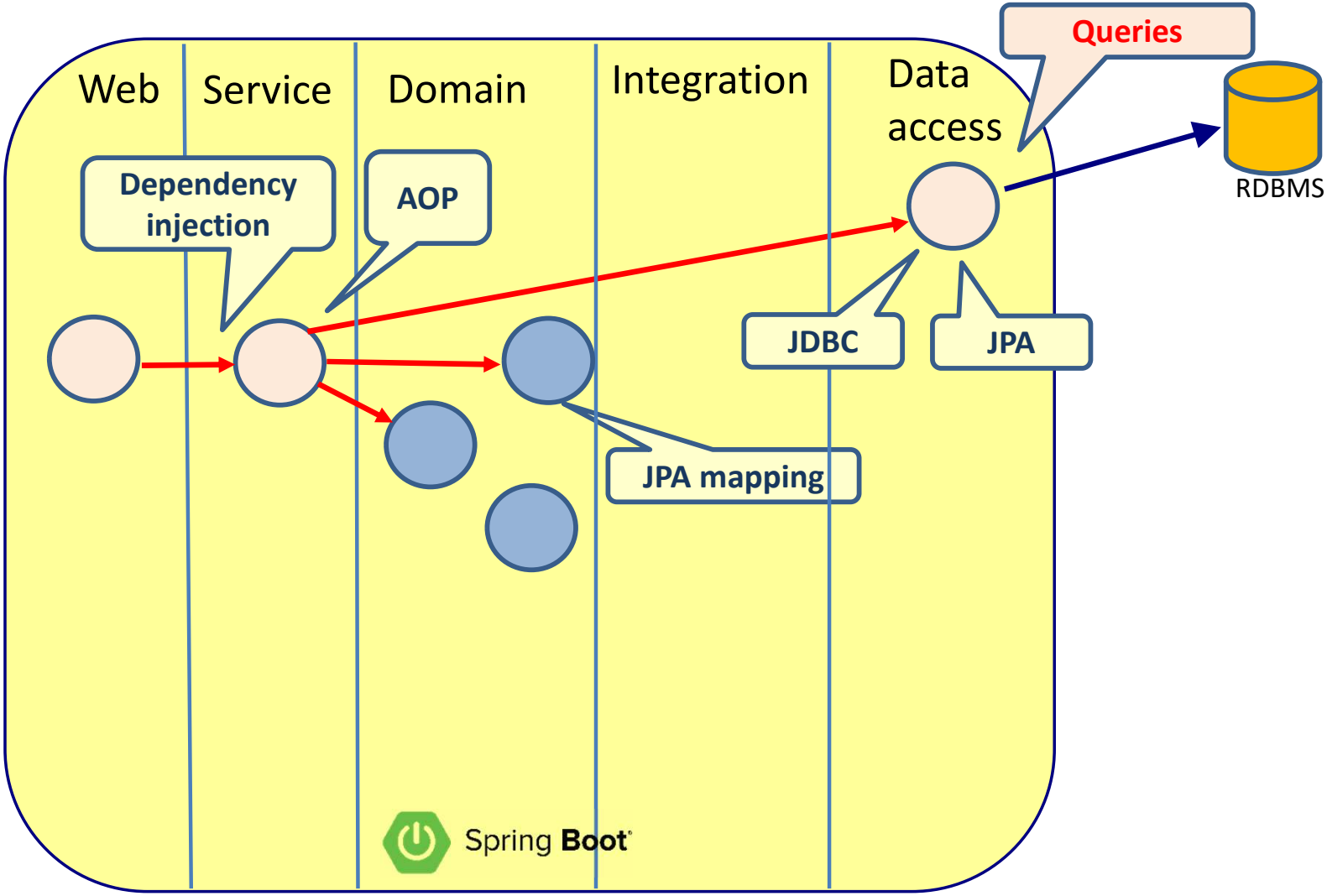

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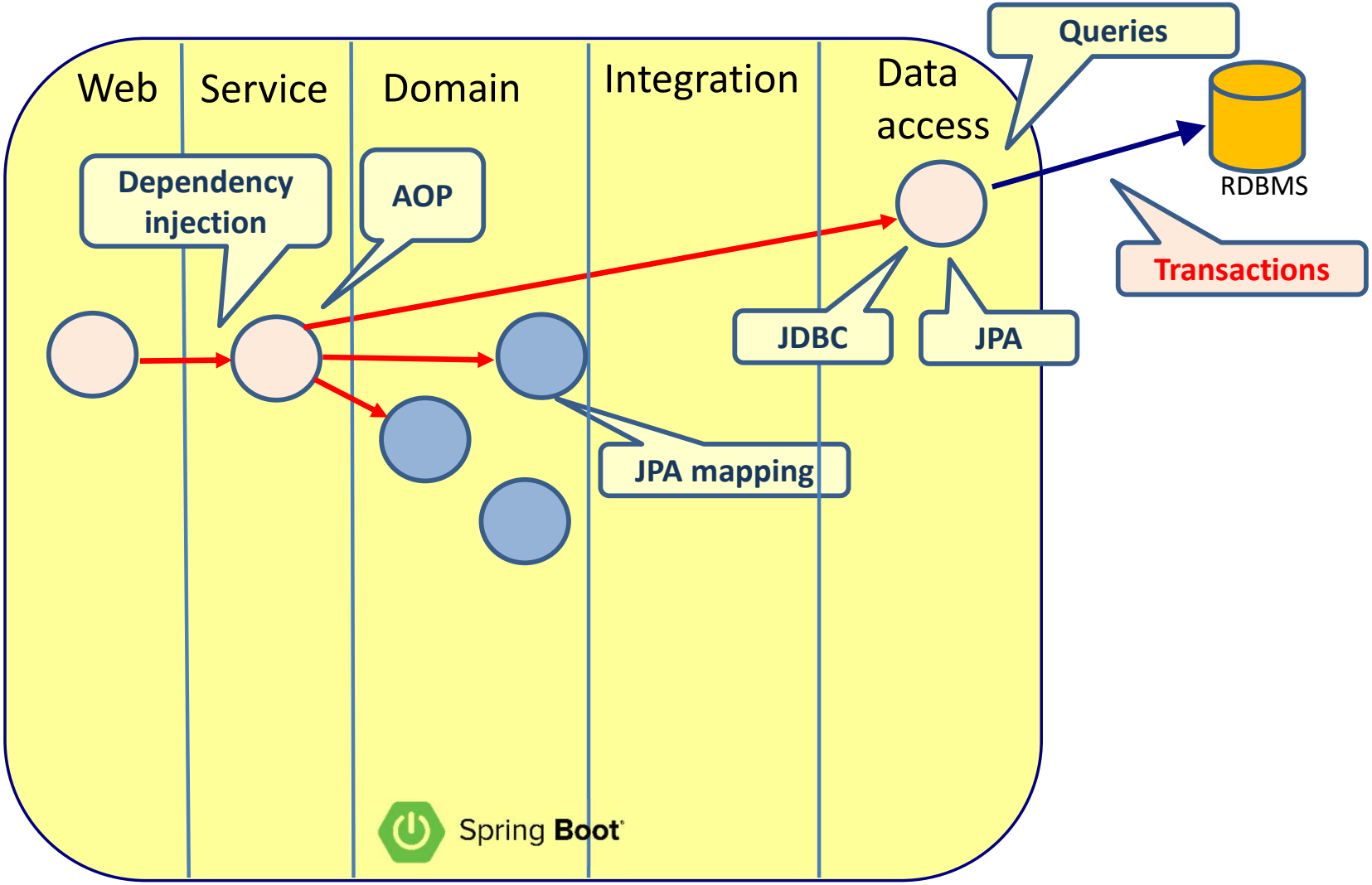

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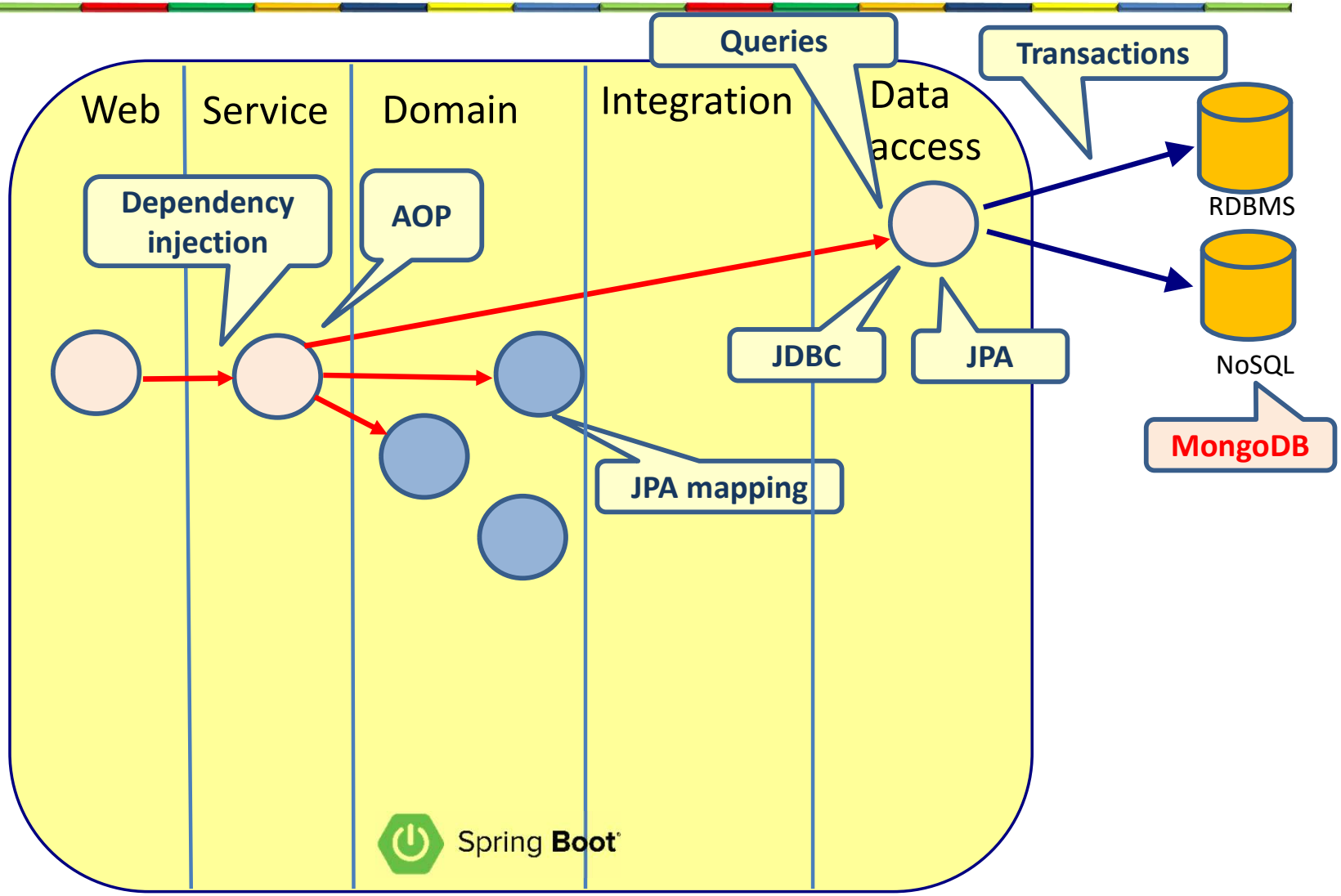

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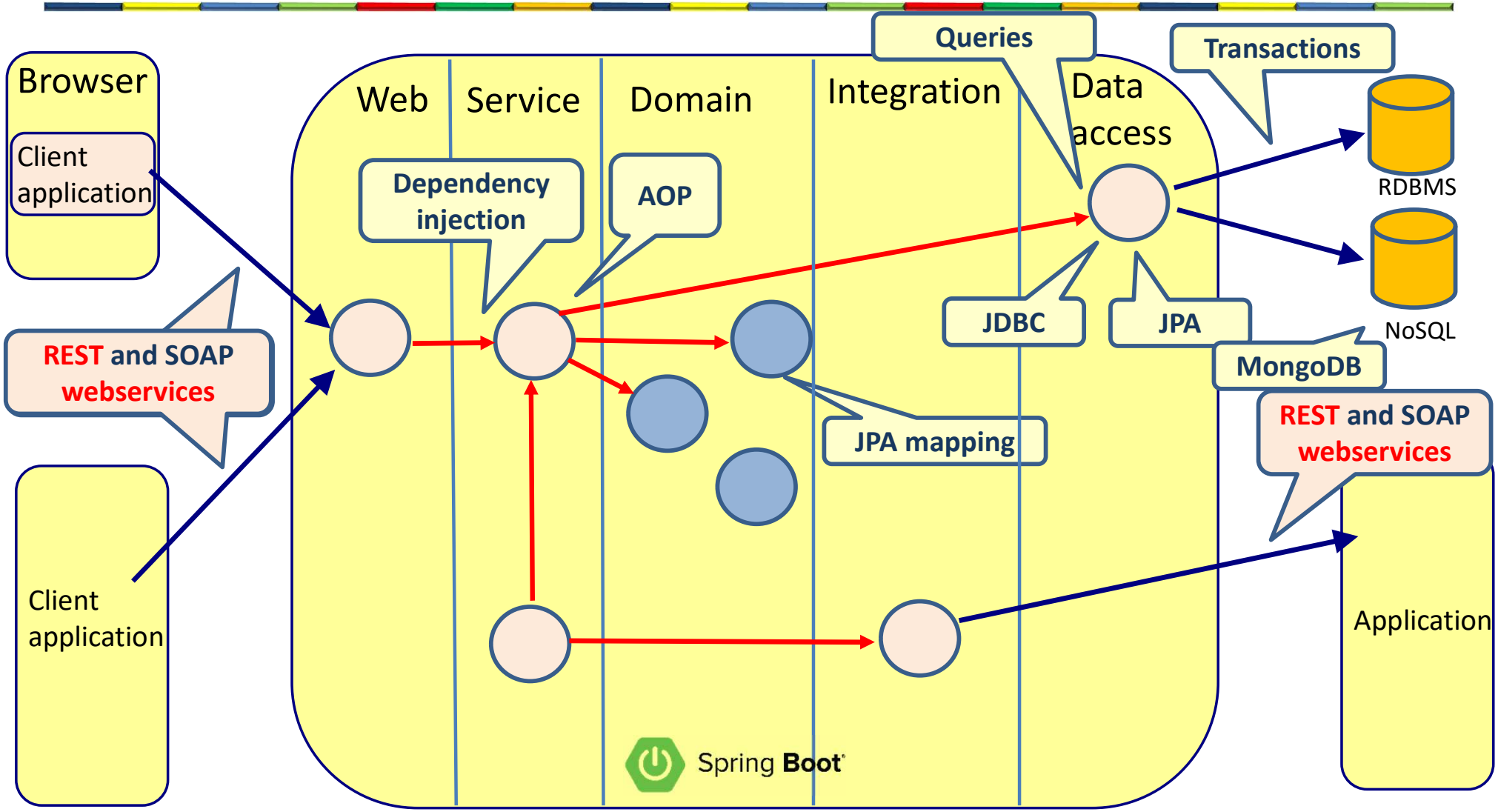

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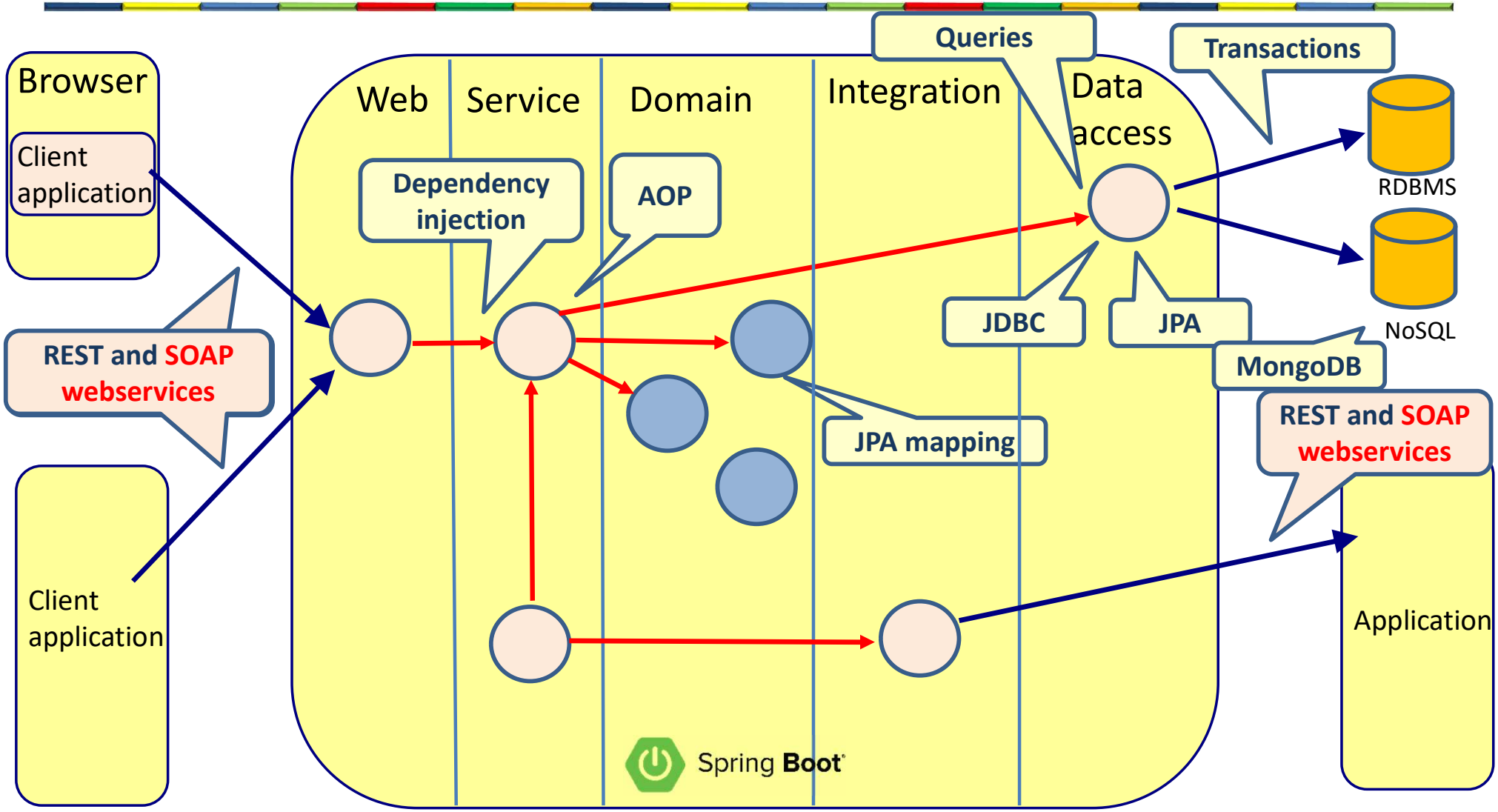

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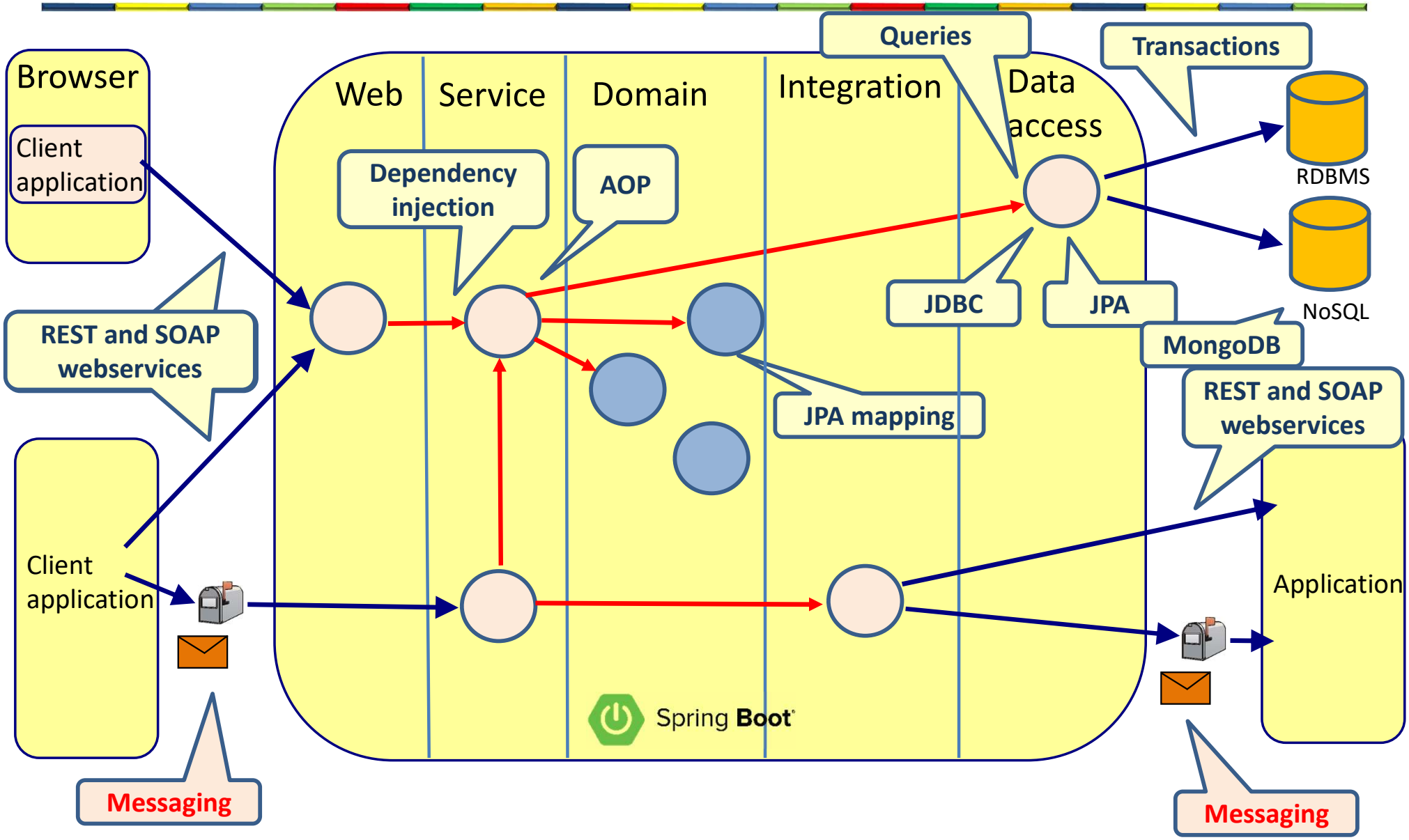

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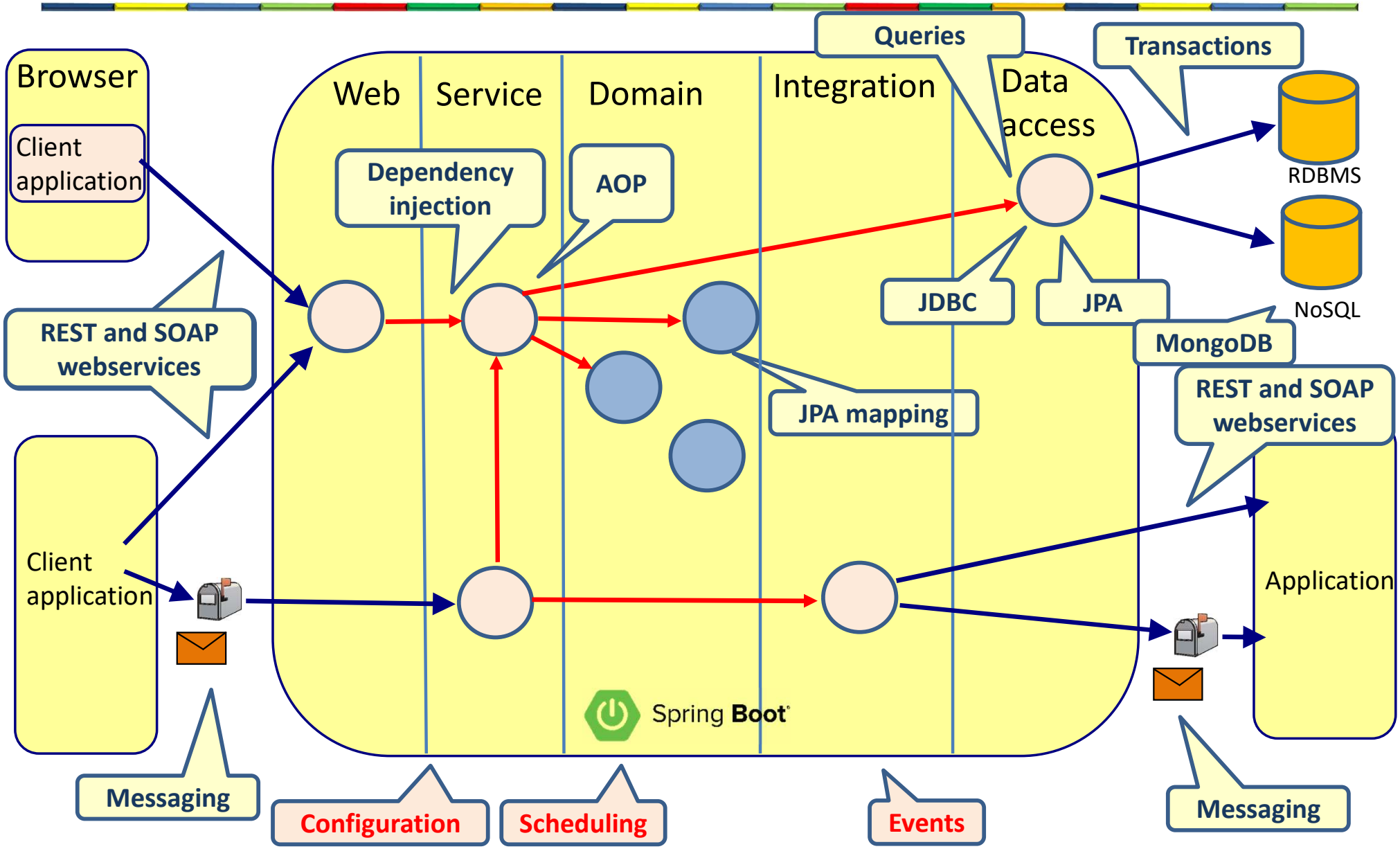

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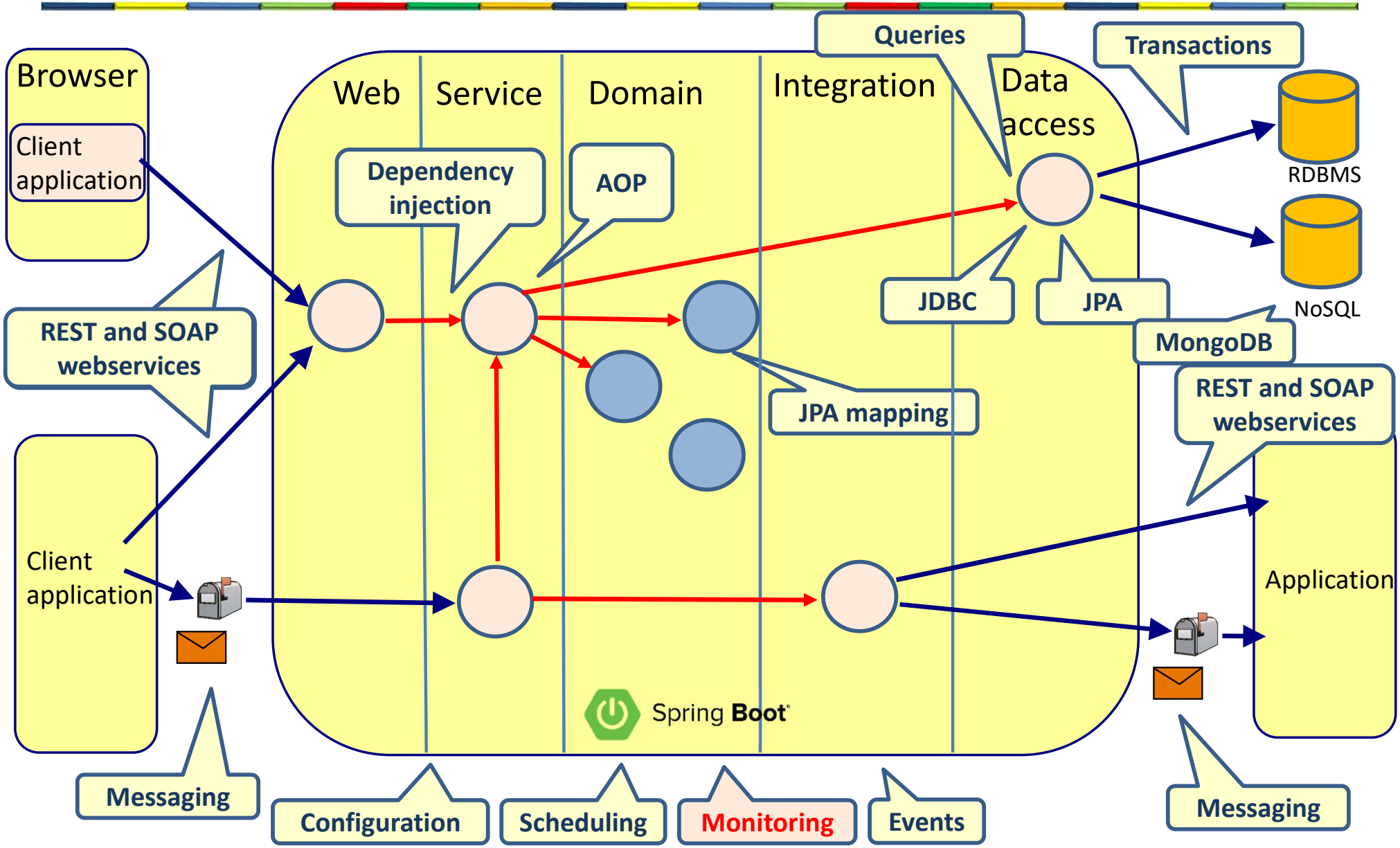

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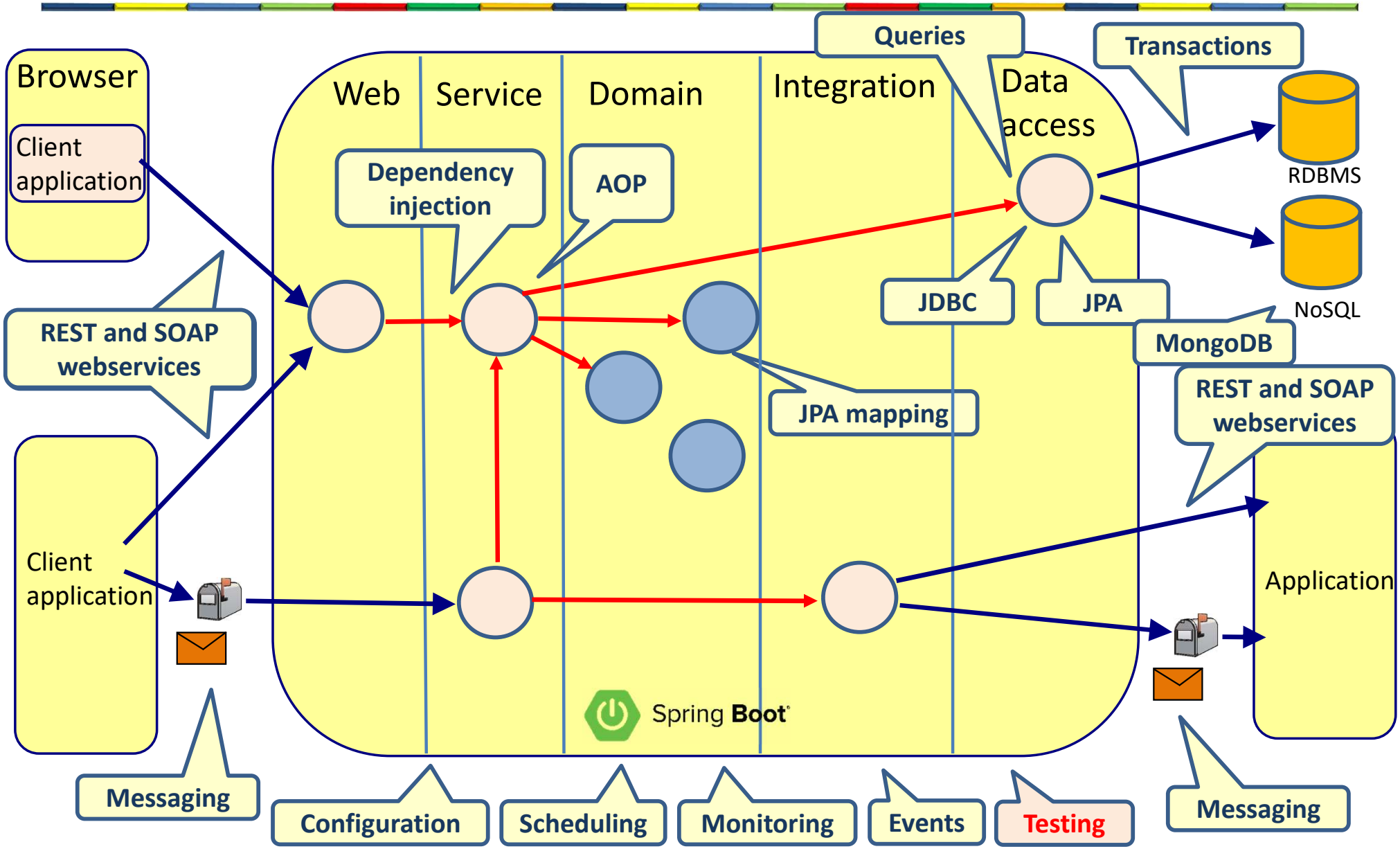

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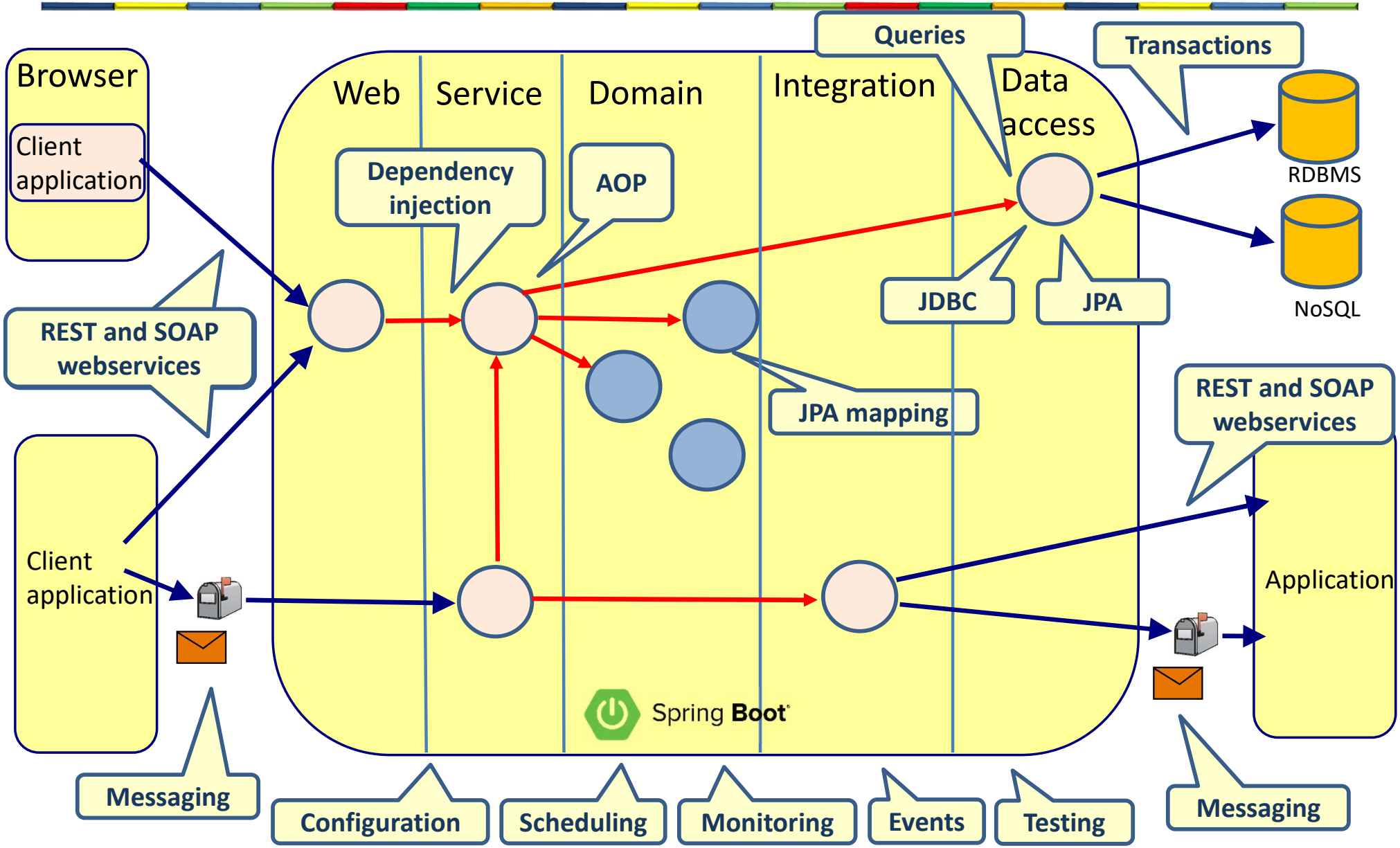
Enterprise Application Architecture



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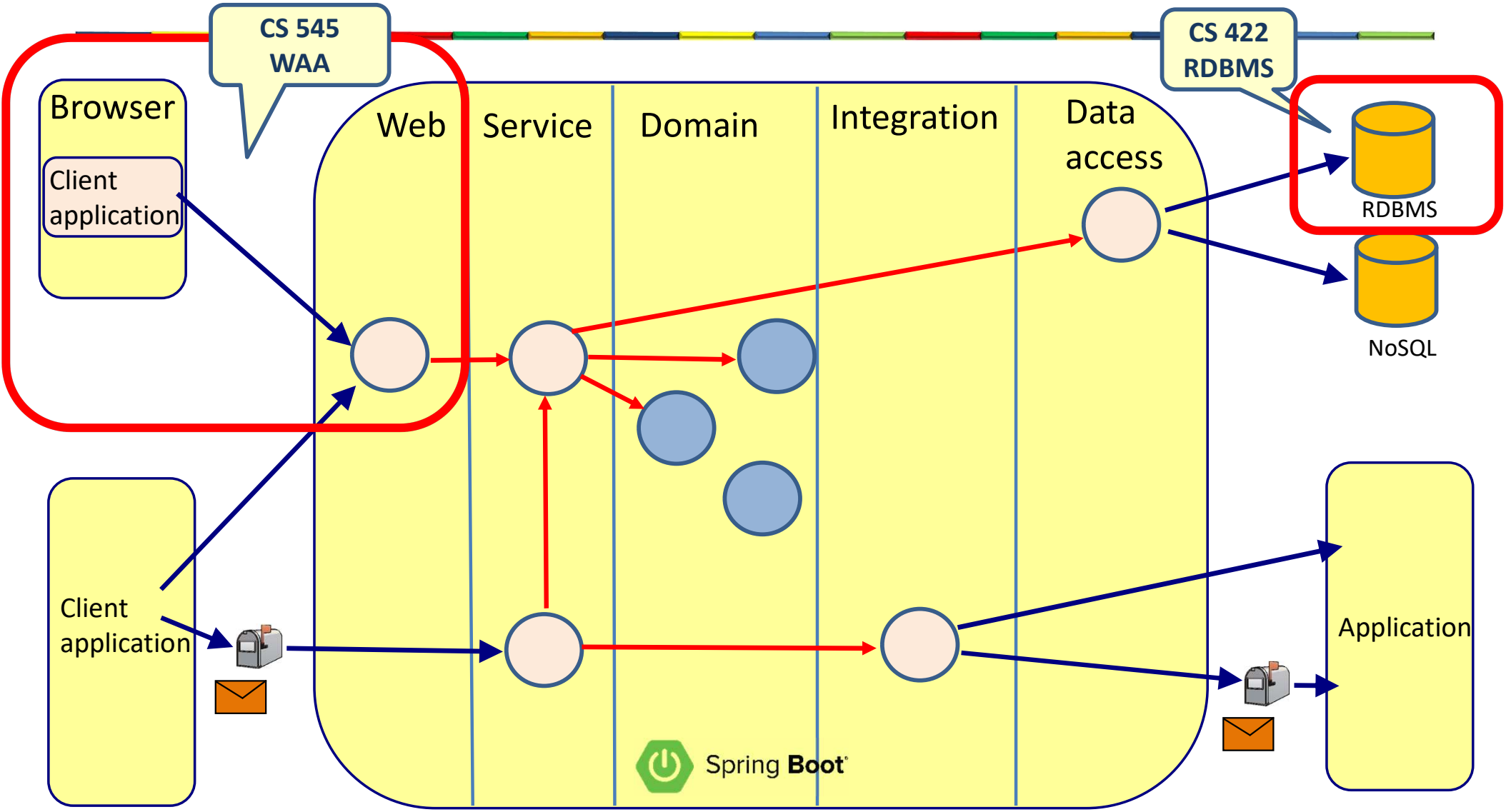
Connection with other courses



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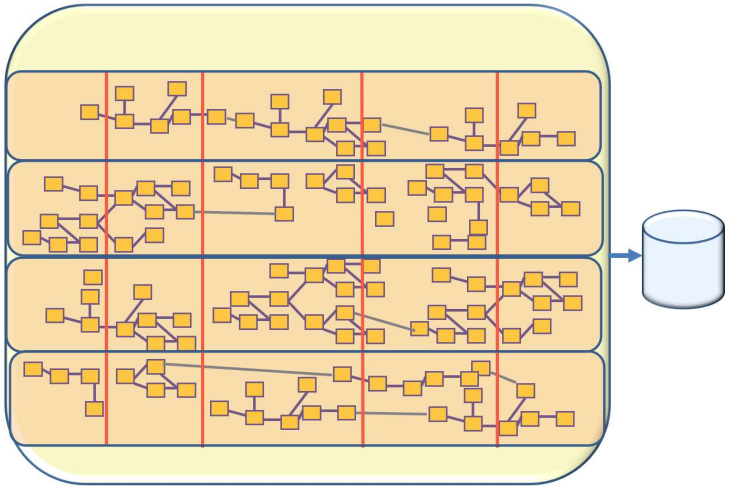
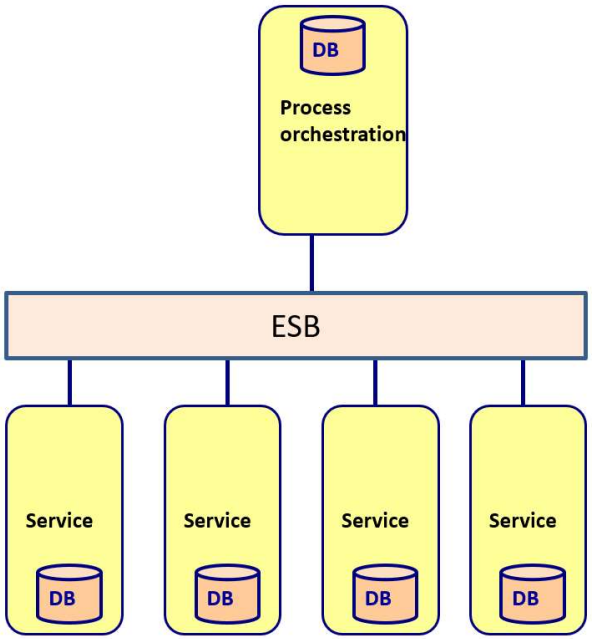
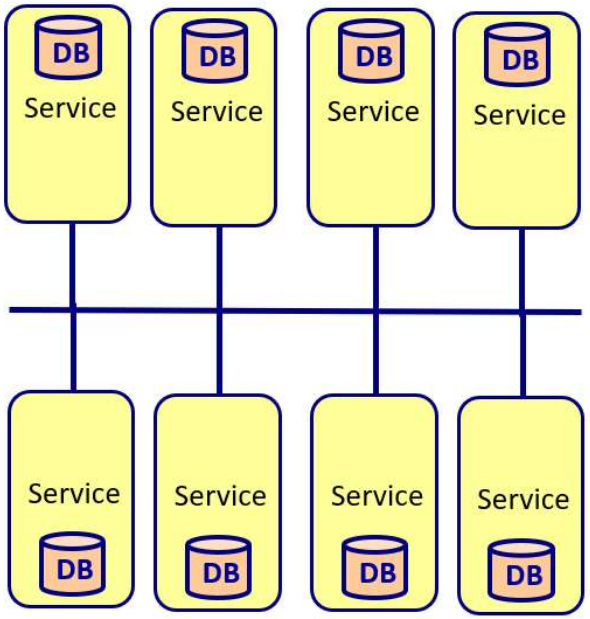


components



SOA



microservices

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INTRODUCTION TO SPRING

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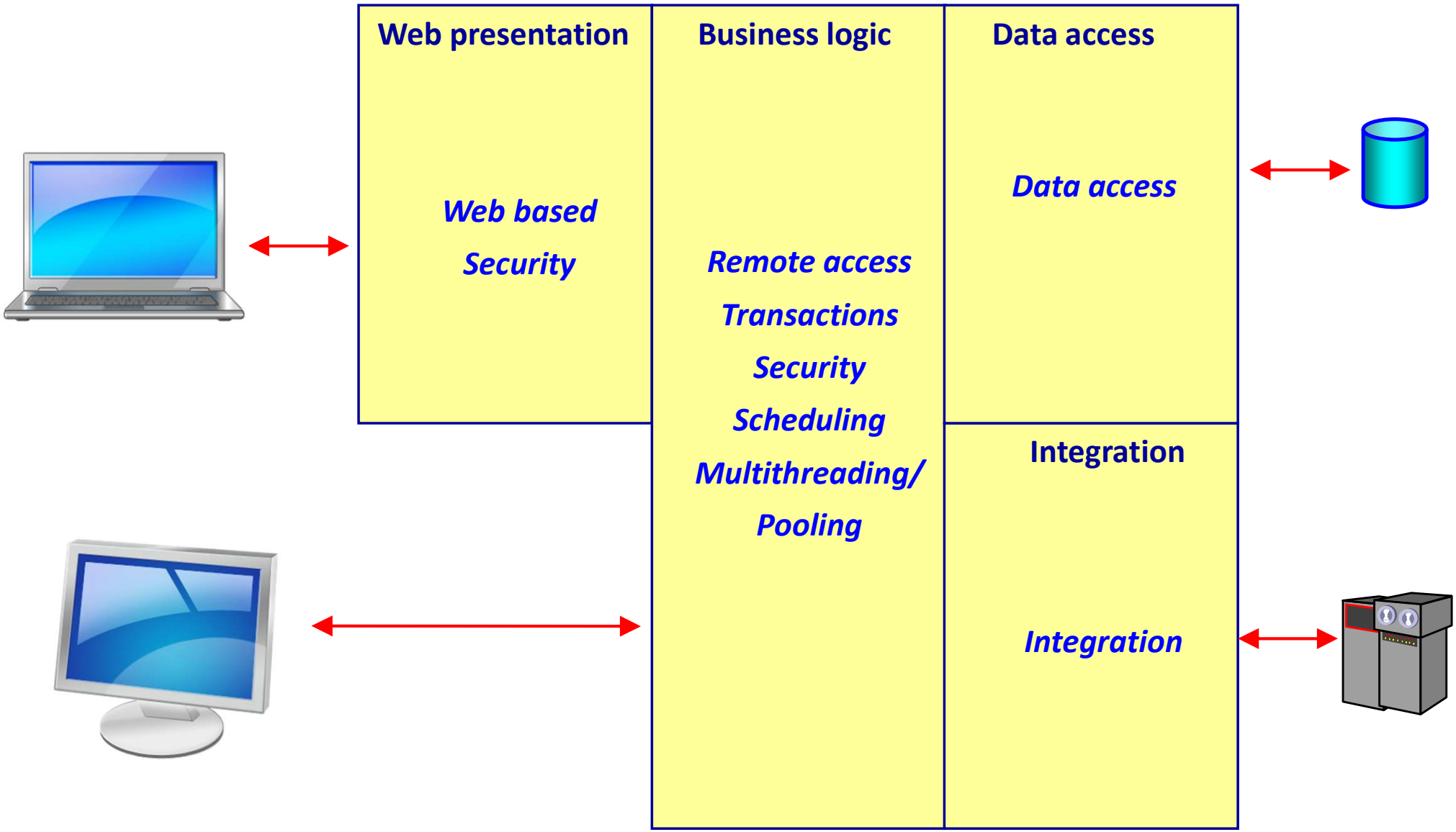
What is an enterprise application?



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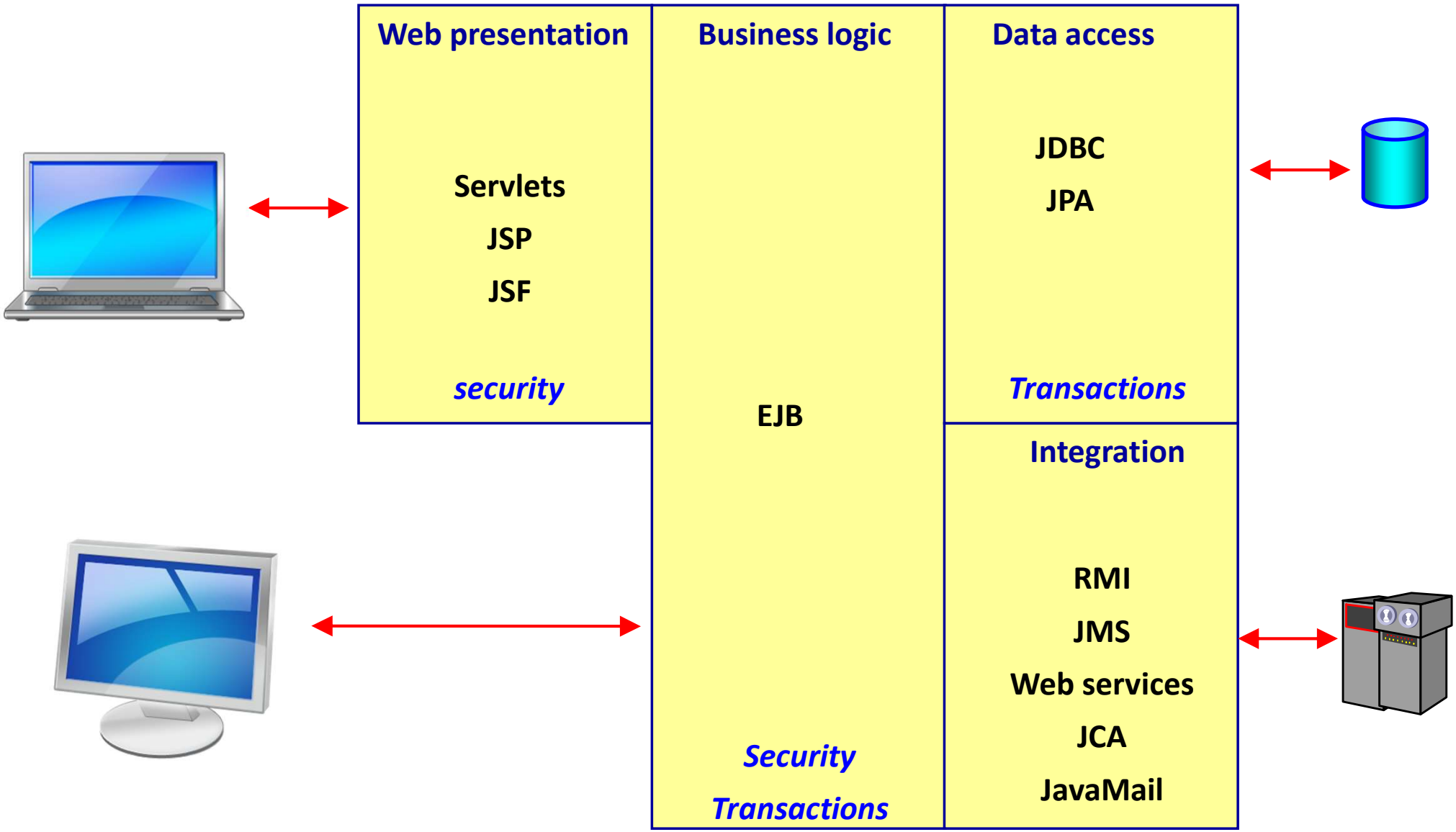
Java EE standard



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What is Spring?

- Lightweight enterprise Java framework
- Open source
- Goal: make developing enterprise Java applications easier

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Aim of the Spring framework

- Make enterprise Java application development as easy as possible following good programming practices
  - POJO-based programming
  - Separation of concern
  - Flexibility

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POJO based programming

- All code is written in java objects
  - No EJB's
- Promotes Object-Oriented principles
- Simple to understand
- Simple to refactor
- Simple to unit test

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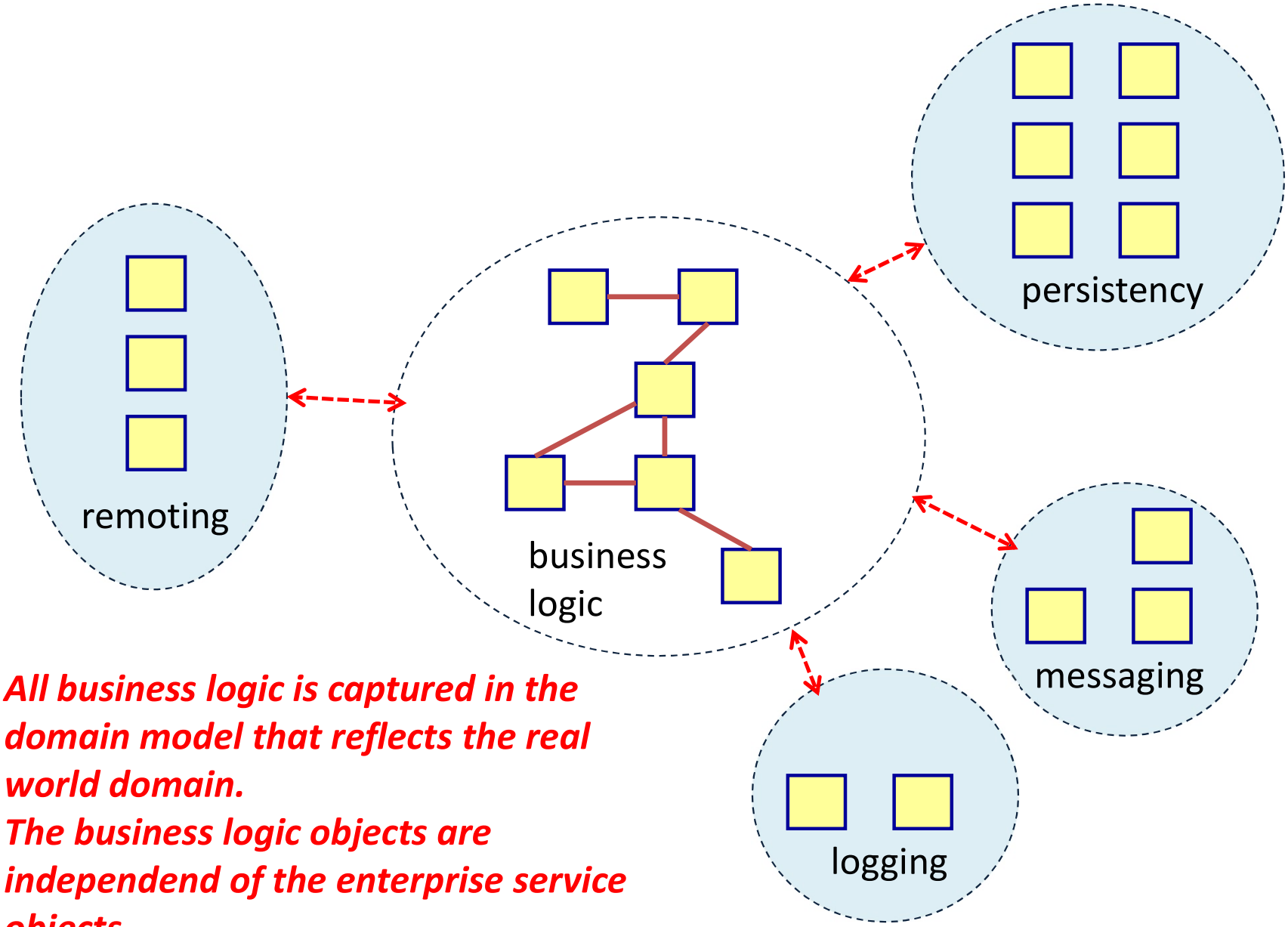
Domain-Driven Design (DDD)



1. ***All business logic is captured in the domain model that reflects the real world domain.***
2. ***The business logic objects are independend of the enterprise service objects***

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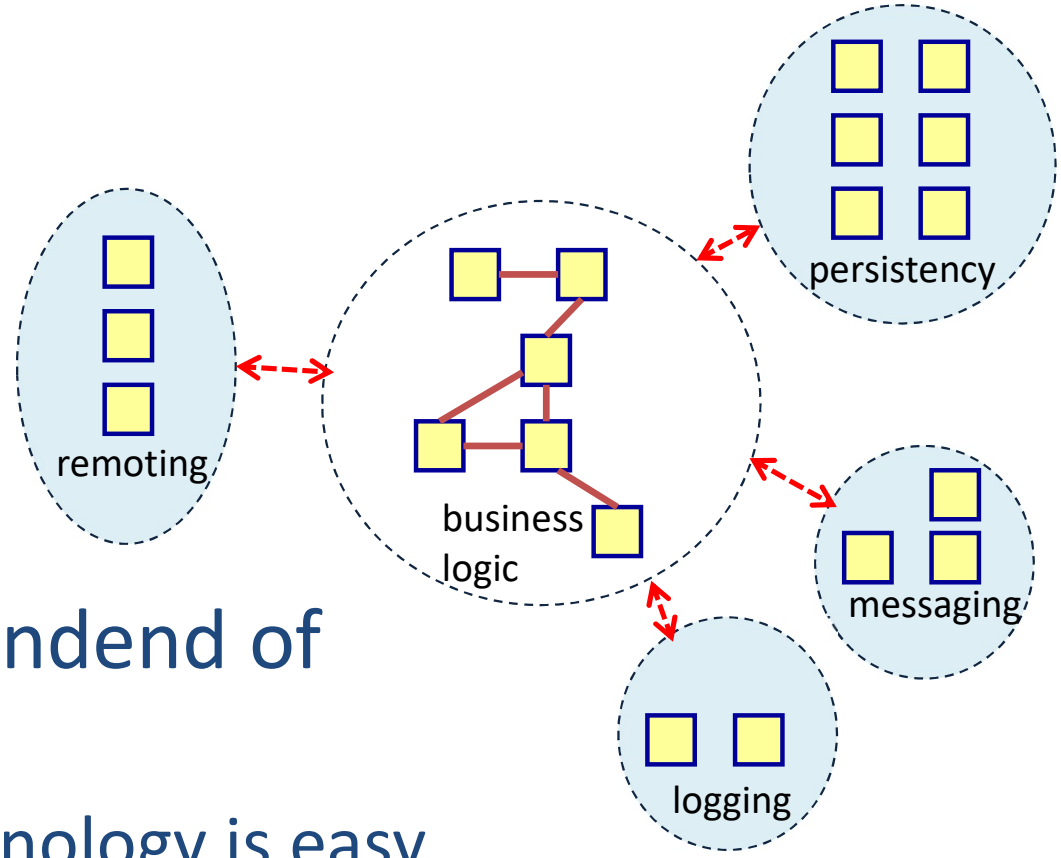
Advantages of DDD



- Business logic is independend of technology changes
  - Switching between technology is easy
- Business logic is easy to understand
  - Easy to write, test, modify

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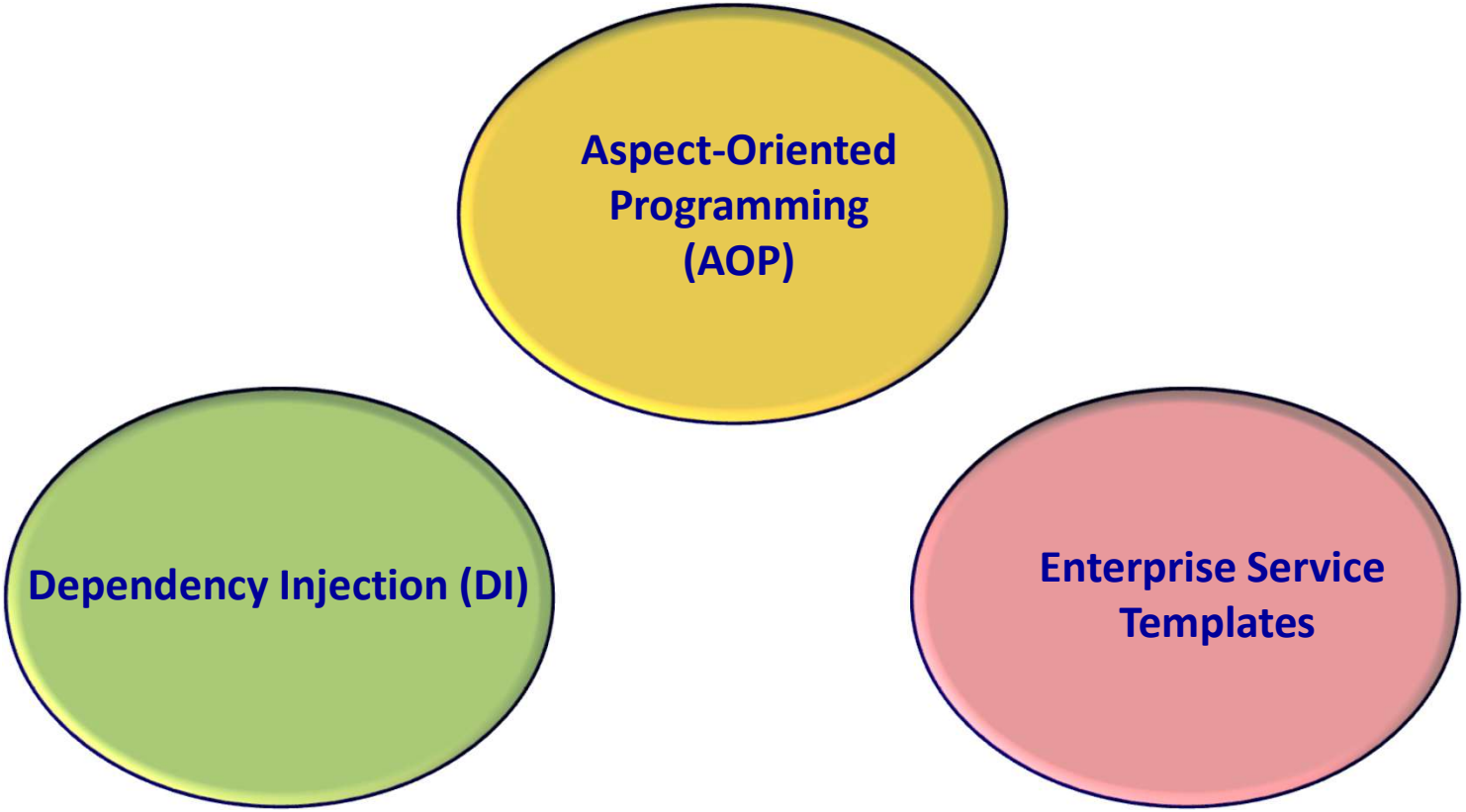
Core of Spring



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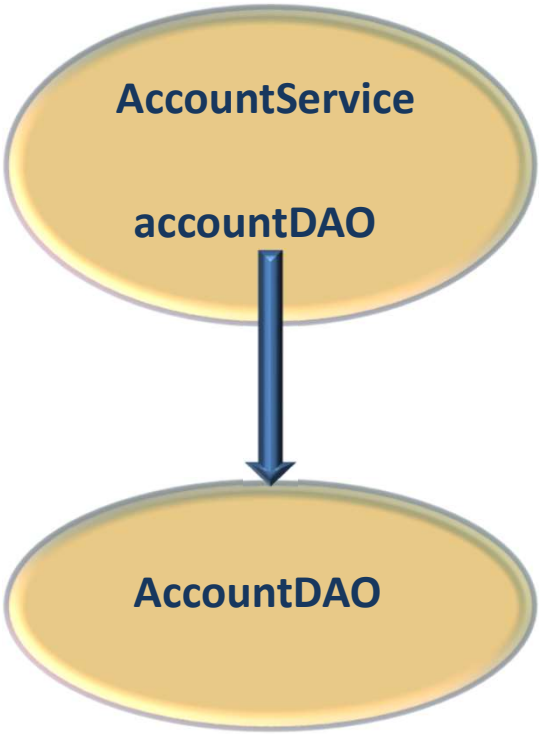
Dependency Injection

- Spring instantiates objects and wires them together

```
public class AccountService {
   private AccountDAO accountDAO;

    public void setAccountDAO(AccountDAO accountDAO) {
        this.accountDAO = accountDAO;
    }

    public Account getAccount(int accountNumber) {
        return accountDAO.loadAccount(accountNumber);
    }
}
```




```
<bean id="accountService" class="bank.AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="bank.dao.AccountDAO" />
```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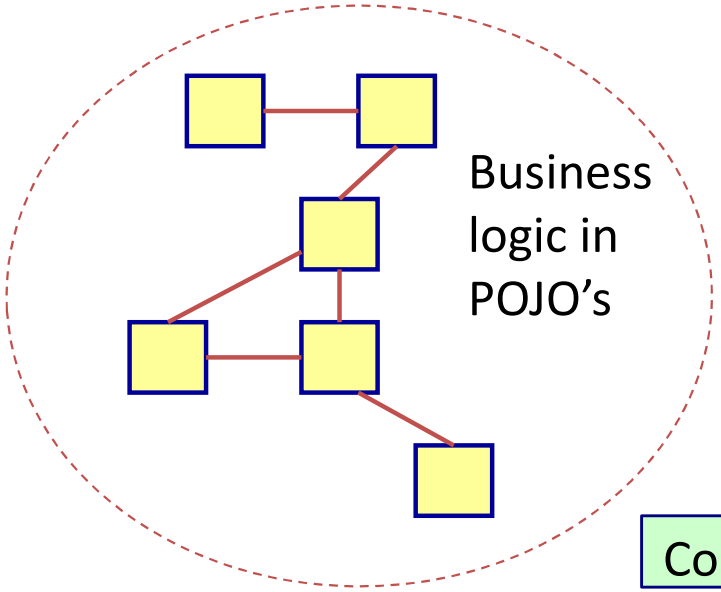
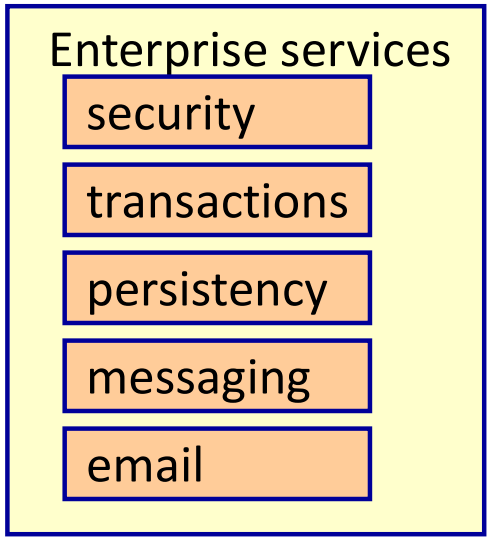
Aspect-Oriented Programming (AOP)

- Separate the crosscutting concerns (plumbing code) from the business logic code
- AOP development
  1. **Write the business logic without worrying about the enterprise services (security, transactions, logging, etc)**
  2. **Write the enterprise services**
  3. **Weave them together**



Configuration file



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Enterprise Service Templates

- Makes programming the different enterprise service API's simpler.
  - JDBC template
  - JMS template
  - JavaMail template
  - Hibernate template

- Let the programmer focus on what needs to happen instead of complexity of the specific API
  - Resource management
  - Exception handling
  - Try-catch-finally-try-catch blocks

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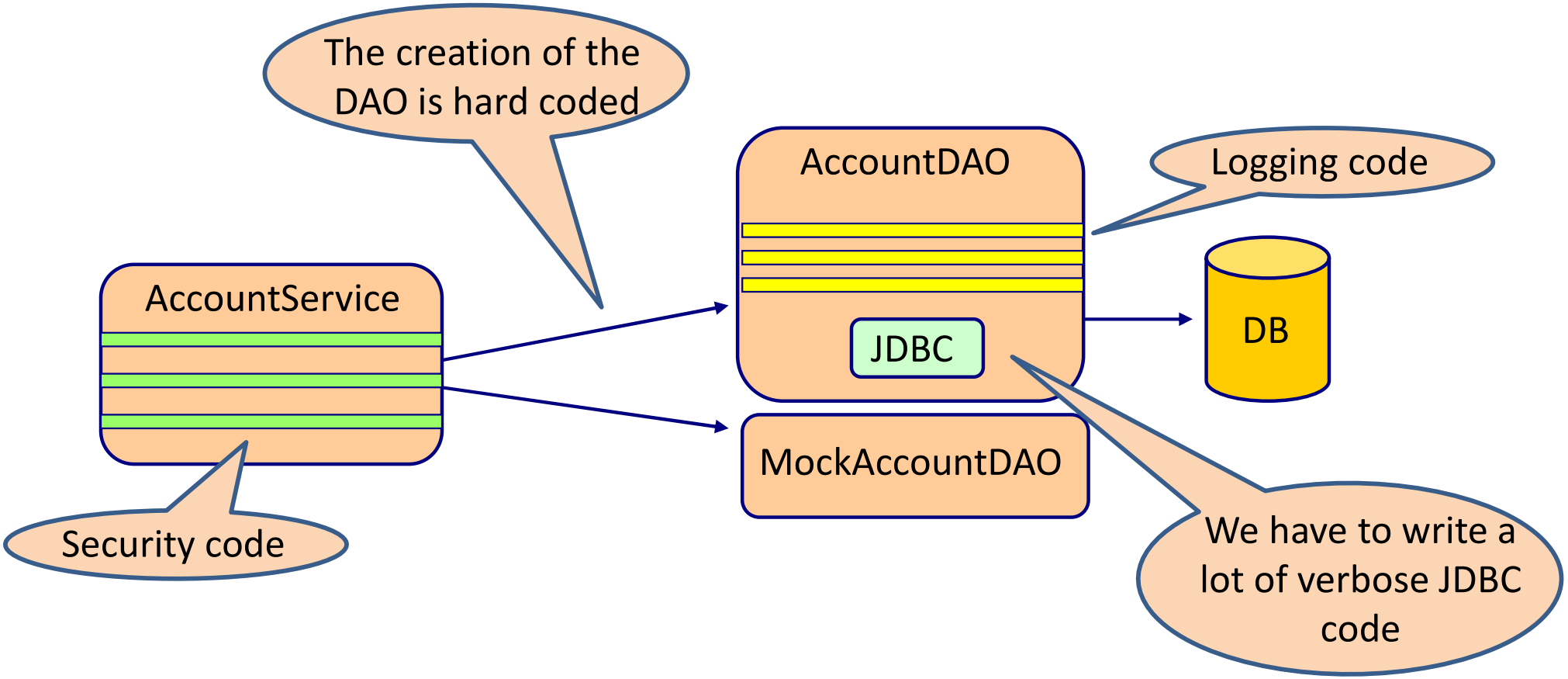
Without Spring



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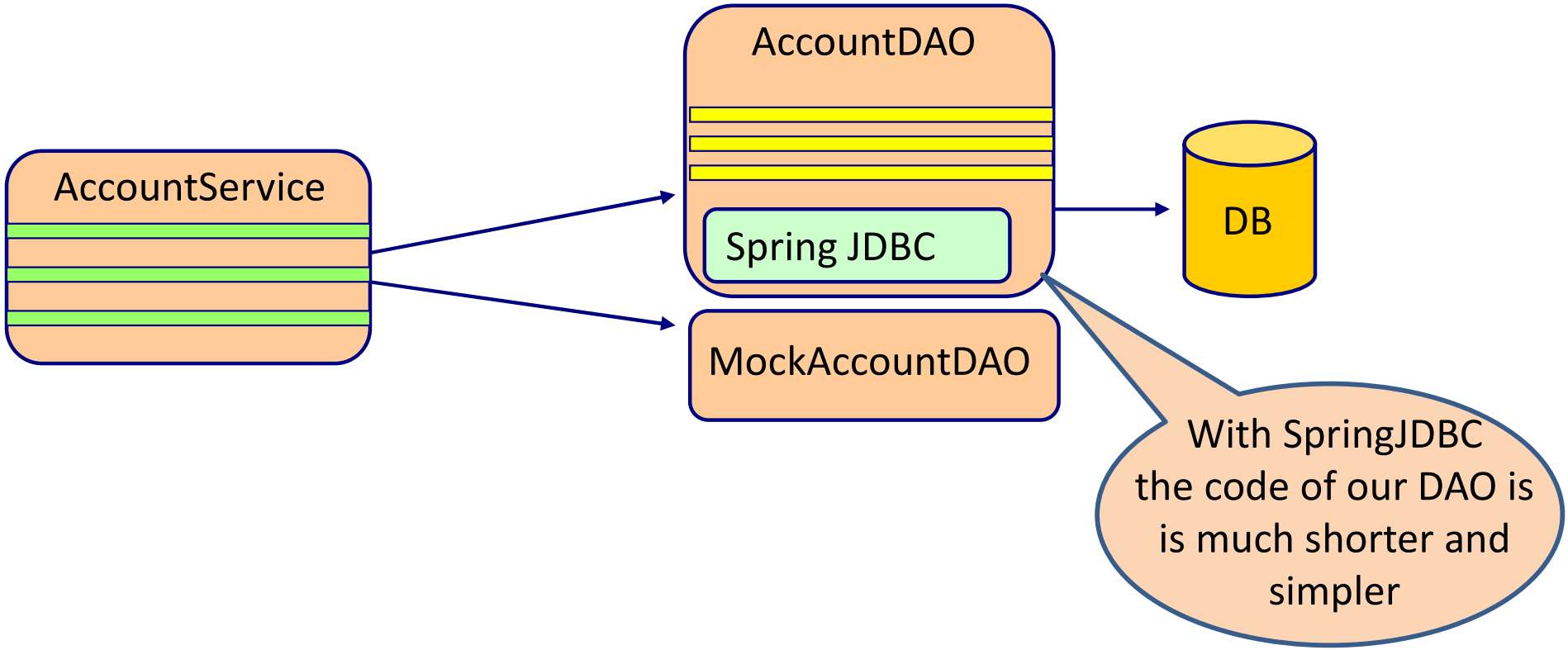
Add SpringJDBC



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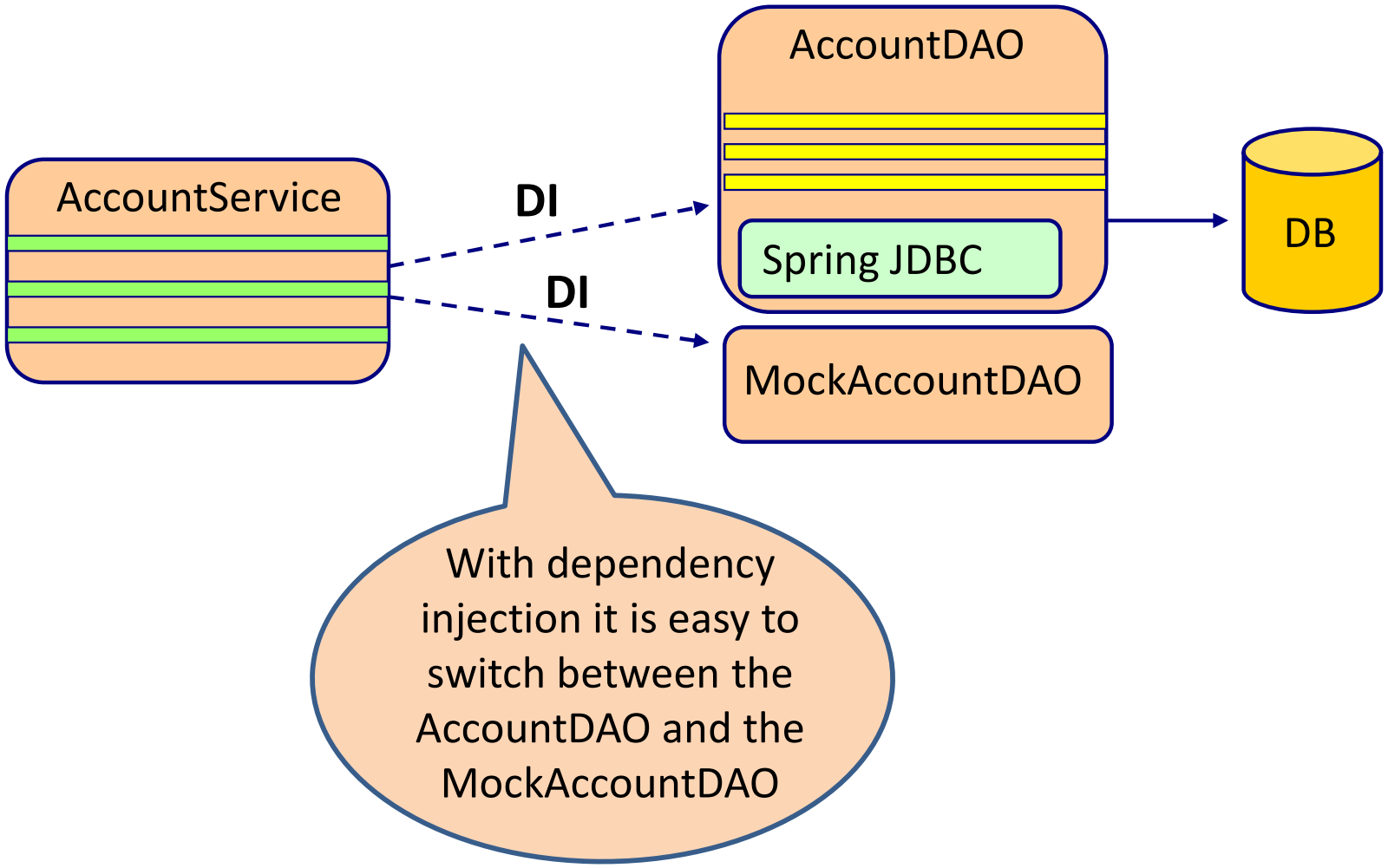
Add Dependency Injection



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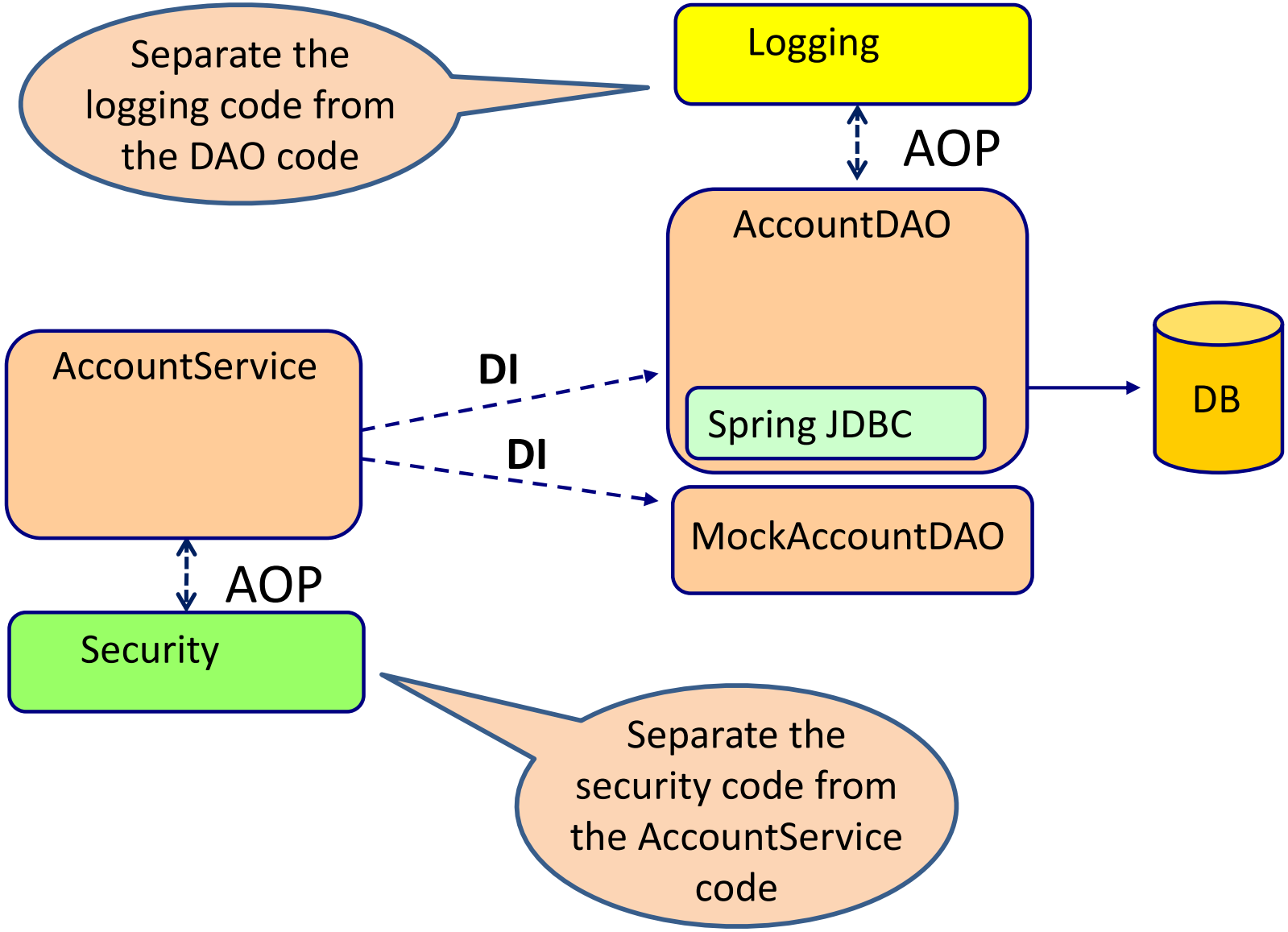
Use AOP



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Spring ecosystem

- Spring (core) framework
- Spring webflow
- Spring integration
- Spring batch
- Spring security
- Spring data
- Spring cloud
- Spring boot

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SPRING BASICS

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A basic Spring application

```
package module2.helloworld;
import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class Application {
  public static void main(String[] args) {
    ApplicationContext context = new
                    ClassPathXmlApplicationContext("module2/helloworld/springconfig.xml");
    CustomerService customerService = context.getBean("customerService", CustomerService.class);
    customerService.sayHello();
  }
}
```

Create an ApplicationContext based on springconfig.xml

Get the bean with id="customerService" from the ApplicationContext

```
package module2.helloworld;

public class CustomerService {
 public void sayHello(){
   System.out.println("Hello from CustomerService");
 }
}
```

springconfig.xml

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

   <bean id="customerService" class="module2.helloworld.CustomerService" />
</beans>
```

Bean declaration

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The spring ApplicationContext

- Reads the Spring XML configuration file
- Instantiates objects declared in the Spring configuration file
- Wires objects together with dependency injection
- Creates proxy objects when needed

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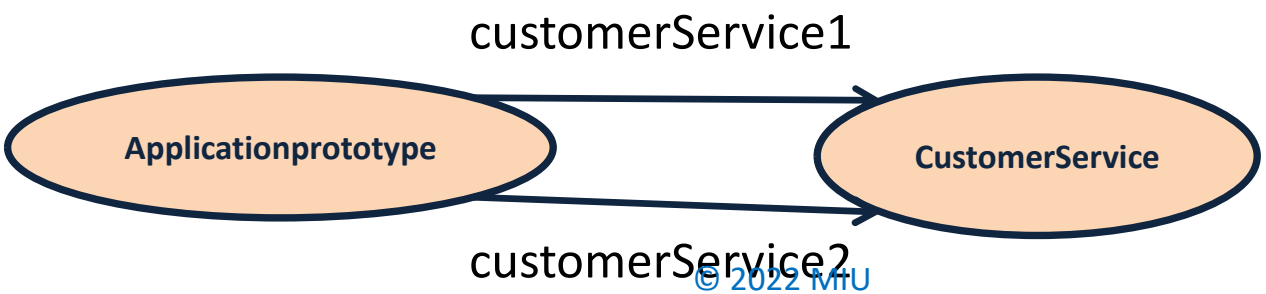
Spring beans are default singletons

```
public class Application{
  public static void main(String[] args) {
    ApplicationContext context = new
                        ClassPathXmlApplicationContext("module2/singleton/springconfig.xml");
    CustomerService customerService1 = context.getBean("customerService", CustomerService.class);
    CustomerService customerService2 = context.getBean("customerService", CustomerService.class);
    System.out.println("customerService1 ="+ customerService1);
    System.out.println("customerService2 ="+ customerService2);
  }
}
```

```
public class CustomerService {
  public CustomerService() {
  }
}
```

```
<bean id="customerService" class="module2.singleton.CustomerService" />
```

```
customerService1 =module2.singleton.CustomerService@29e357
customerService2 =module2.singleton.CustomerService@29e357
```



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Prototype beans

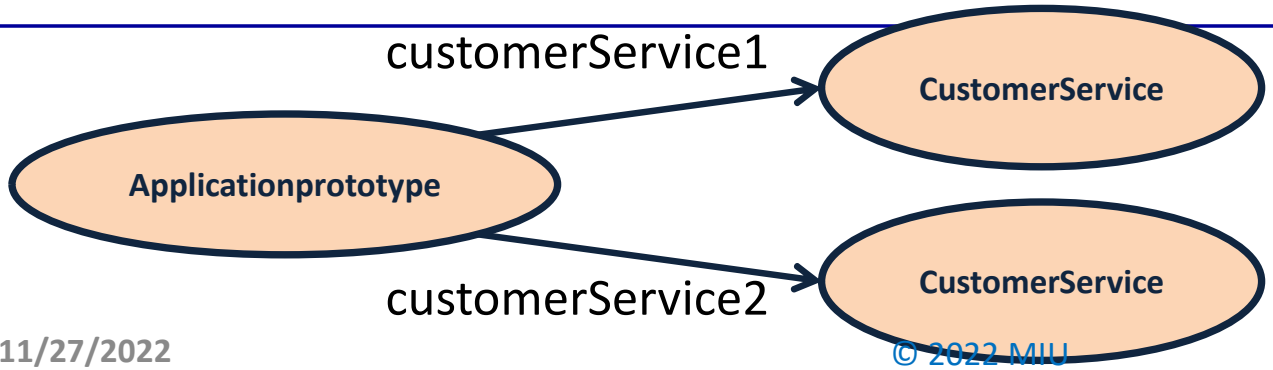
```
public class Application{
  public static void main(String[] args) {
    ApplicationContext context =
                  new ClassPathXmlApplicationContext("module2/prototype/springconfig.xml");
    CustomerService customerService1 = context.getBean("customerService", CustomerService.class);
    CustomerService customerService2 = context.getBean("customerService", CustomerService.class);
    System.out.println("customerService1 ="+ customerService1);
    System.out.println("customerService2 ="+ customerService2);
  }
}
```

```
public class CustomerService {
    public CustomerService() {
    }
}
```

```
<bean id="customerService" class="module2.prototype.CustomerService" scope="prototype" />
```

prototype

```
customerService1 =module2.prototype.CustomerService@1632847
customerService2 =module2.prototype.CustomerService@e95a56
```



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Eager-instantiation of beans

```
public class Application {
  public static void main(String[] args) {
    System.out.println("1");
    ApplicationContext context = new
           ClassPathXmlApplicationContext("/module2/eagerinstantiation/springconfig.xml");
    System.out.println("2");
    CustomerService customerService = context.getBean("customerService", CustomerService.class);
    System.out.println("3");
    customerService.addCustomer("Frank Brown");
    System.out.println("4");
  }
}
```

```
public class CustomerServiceImpl implements CustomerService {
  public CustomerServiceImpl() {
    System.out.println("calling constructor of CustomerServiceImpl");
  }

  public void addCustomer(String customername) {
    System.out.println("calling addCustomer of CustomerServiceImpl");
  }
}
```

```
<bean id="customerService" class="module2.eagerinstantiation.CustomerServiceImpl" />
```

```
1
calling constructor of CustomerServiceImpl
2
3
calling addCustomer of CustomerServiceImpl
4
```

The CustomerService bean is eagerly instantiated

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Lazy-instantiation of beans

```
public class Application {
  public static void main(String[] args) {
    System.out.println("1");
    ApplicationContext context = new
         ClassPathXmlApplicationContext("/module2/lazyinstantiation/springconfiglazy.xml");
    System.out.println("2");
    CustomerService customerService = context.getBean("customerService", CustomerService.class);
    System.out.println("3");
    customerService.addCustomer("Frank Brown");
    System.out.println("4");
  }
}
```

```
public class CustomerServiceImpl implements CustomerService {
  public CustomerServiceImpl() {
    System.out.println("calling constructor of CustomerServiceImpl");
  }

  public void addCustomer(String customername) {
    System.out.println("calling addCustomer of CustomerServiceImpl");
  }
}
```

```
<bean id="customerService" class="module2.lazyinstantiation.CustomerServiceImpl"
      lazy-init="true" />
```

Lazy instantiation

```
1
2
calling constructor of CustomerServiceImpl
3
calling addCustomer of CustomerServiceImpl
4
```

The CustomerService bean is lazy instantiated

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Lifecycle methods

```
public interface CustomerService {
  public void addCustomer(String customername);
  public void init();
  public void cleanup();
}
```

```
public class CustomerServiceImpl implements CustomerService {
  public CustomerServiceImpl() {
    System.out.println("calling constructor of CustomerServiceImpl");
  }
  public void addCustomer(String customername) {
    System.out.println("calling addCustomer of CustomerServiceImpl");
  }
  public void init() {
    System.out.println("calling init method of CustomerService");
  }
  public void cleanup() {
    System.out.println("calling cleanup method of CustomerService");
  }
}
```

```
<bean id="customerService" class="module2.xmllifecycle.CustomerServiceImpl"
      init-method="init" destroy-method="cleanup"/>
```

Method called just after the constructor

Method called when you close the ApplicationContext

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Lifecycle methods example

```
public class Application {
  public static void main(String[] args) {
    System.out.println("1");
    ConfigurableApplicationContext  context = new
                    ClassPathXmlApplicationContext("/module2/xmllifecycle/springconfig.xml");
    System.out.println("2");
    CustomerService customerService = context.getBean("customerService", CustomerService.class);
    System.out.println("3");
    customerService.addCustomer("Frank Brown");
    System.out.println("4");
    context.close();
  }
}
```

ConfigurableApplicationContext

Close the ApplicationContext

```
1
calling constructor of CustomerServiceImpl
calling init method of CustomerService
2
3
calling addCustomer of CustomerServiceImpl
4
calling cleanup method of CustomerService
```

init method

cleanup method

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Lifecycle methods with annotations

```
import javax.annotation.PostConstruct;
import javax.annotation.PreDestroy;

public class CustomerServiceImpl implements CustomerService {
  public CustomerServiceImpl() {
    System.out.println("calling constructor of CustomerServiceImpl");
  }
  public void addCustomer(String customername) {
    System.out.println("calling addCustomer of CustomerServiceImpl");
  }
  @PostConstruct
  public void init() {
    System.out.println("calling init method of CustomerService");
  }
  @PreDestroy
  public void cleanup() {
    System.out.println("calling cleanup method of CustomerService");
  }
}
```

@PostConstruct

@PreDestroy

```
1
calling constructor of CustomerServiceImpl
calling init method of CustomerService
2
3
calling addCustomer of CustomerServiceImpl
4
calling cleanup method of CustomerService
```

init method

cleanup method

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Lifecycle methods with annotations

```
<?xml version="1.0" encoding="UTF-8"?>
<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-3.0.xsd"
           http://www.springframework.org/schema/context
           http://www.springframework.org/schema/context/spring-context-3.0.xsd">

   <context:annotation-config/>
   <bean id="customerService" class="module2.annotationslifecycle.CustomerServiceImpl"/>
</beans>
```

Tells Spring to check for annotation configuration in the Spring beans

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DEPENDENCY INJECTION

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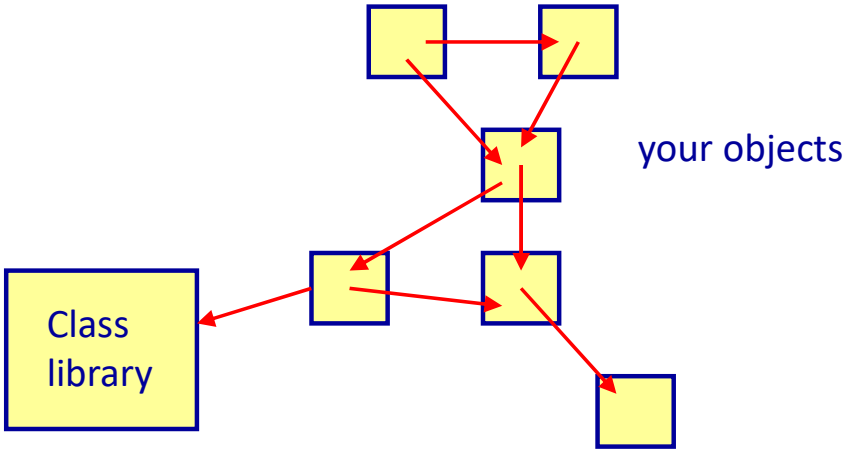
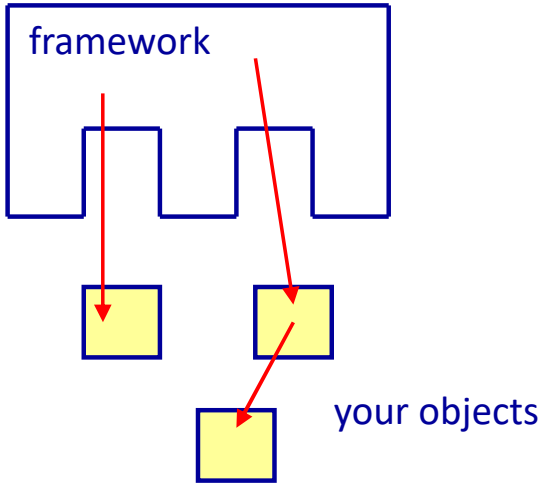
Inversion of Control (IoC)

- Hollywood principle: Don't call us, we'll call you
- The framework has control over your code



Your code calls the class library



IoC: The framework calls your code

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Different way's to "wire"2 object together

1. Instantiate an object directly
2. Use an interface
3. Use a factory object
4. Use Spring Dependency Injection

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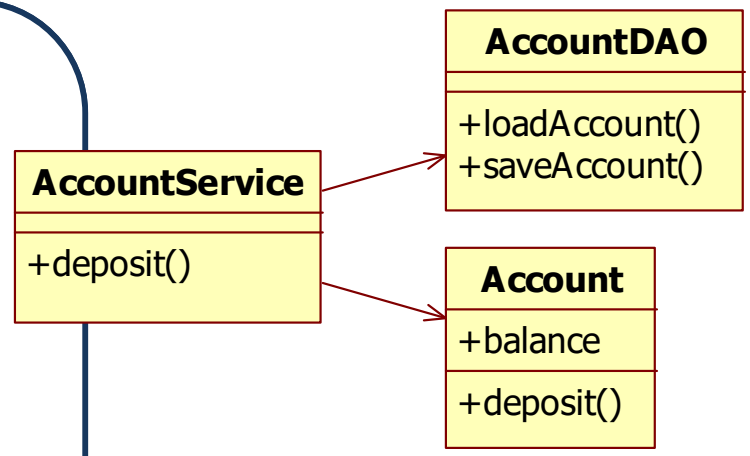
1. Instantiate an object directly

```
public class AccountService {
  private AccountDAO accountDAO;

  public AccountService() {
    accountDAO = new AccountDAO();
  }

  public void deposit(long accountNumber, double amount){
    Account account=accountDAO.loadAccount(accountNumber);
    account.deposit(amount);
    accountDAO.saveAccount(account);
  }
}
```



- The relation between AccountService and AccountDAO is hard coded
  - If you want to change the AccountDAO implementation, you have to change the code

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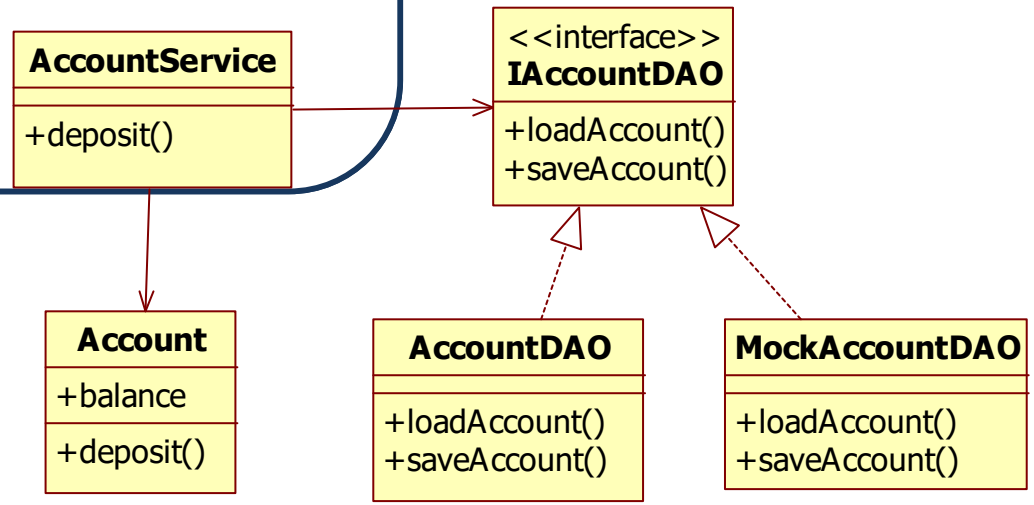
2. Use an Interface

```
public class AccountService {
  private IAccountDAO accountDAO;

  public AccountService() {
    accountDAO = new AccountDAO();
  }

  public void deposit(long accountNumber, double amount){
    Account account=accountDAO.loadAccount(accountNumber);
    account.deposit(amount);
    accountDAO.saveAccount(account);
  }
}
```

accountDAO is of type IAccountDAO



- The relation between AccountService and AccountDAO is still hard-coded
  - We have more flexibility, but if you want to change the AccountDAO implementation to the MockAccountDAO, you have to change the code

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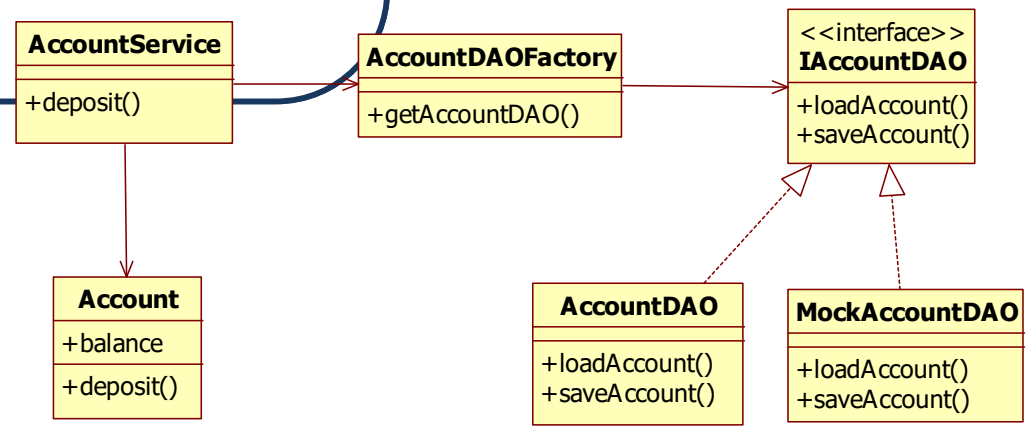
3. Use a factory object

```
public class AccountService {
  private IAccountDAO accountDAO;

  public AccountService() {
    AccountDAOFactory daoFactory = new AccountDAOFactory();
    accountDAO = daoFactory.getAccountDAO();
  }

  public void deposit(long accountNumber, double amount){
    Account account=accountDAO.loadAccount(accountNumber);
    account.deposit(amount);
    accountDAO.saveAccount(account);
  }
}
```

The factory creates
The accountDAO object



- The relation between AccountService and AccountDAO is still hard coded
  - We have more flexibility, but if you want to change the AccountDAO implementation to the MockAccountDAO, you have to change code in the factory

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4. Use Spring Dependency Injection

```
public class AccountService {
  private IAccountDAO accountDAO;

  public void setAccountDAO(IAccountDAO accountDAO) {
    this.accountDAO = accountDAO;
  }

  public void deposit(long accountNumber, double amount){
    Account account=accountDAO.loadAccount(accountNumber);
    account.deposit(amount);
    accountDAO.saveAccount(account);
  }
}
```

accountDAO is injected by the Spring framework

```
<bean id="accountService" class="AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
<bean id="mockAccountDAO" class="MockAccountDAO" />
```

- The attribute accountDAO is configured in XML and the Spring framework takes care that accountDAO references the AccountDAO object.

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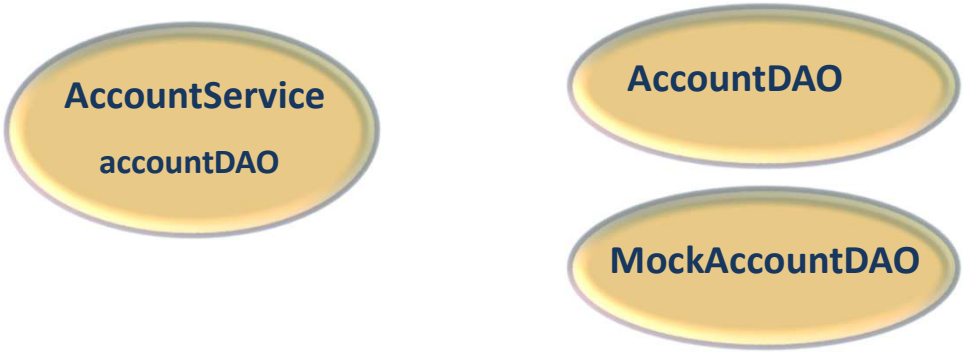
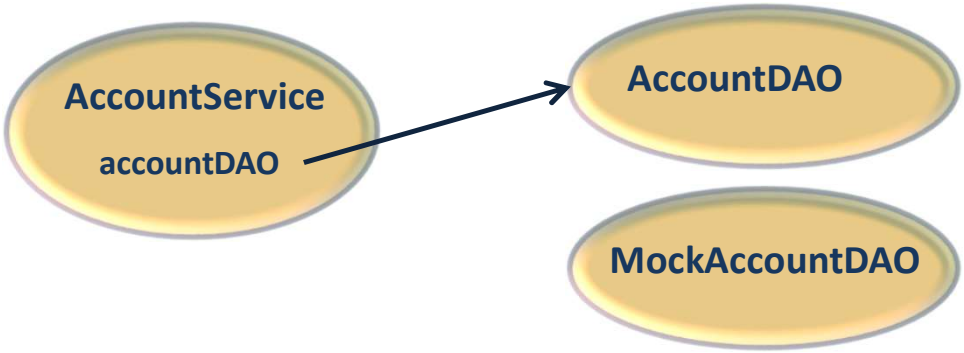
How does DI work?

```
<bean id="accountService" class="AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
<bean id="mockAccountDAO" class="MockAccountDAO" />
```

1. Spring instantiates all beans in the XML configuration file



2. Spring then connects the accountDAO attribute to the AccountDAO instance



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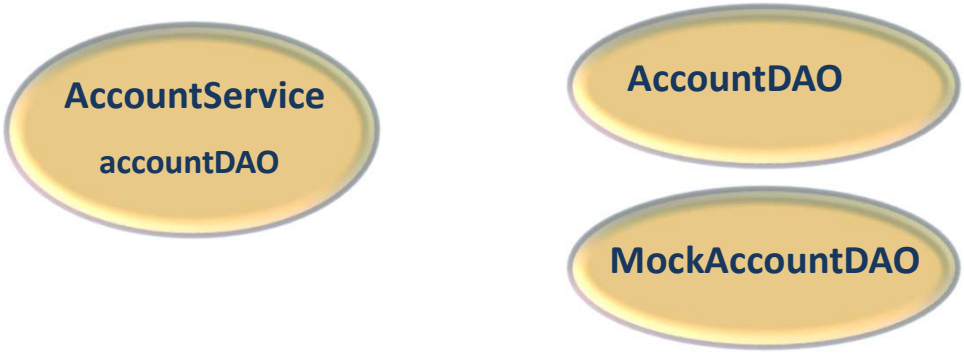
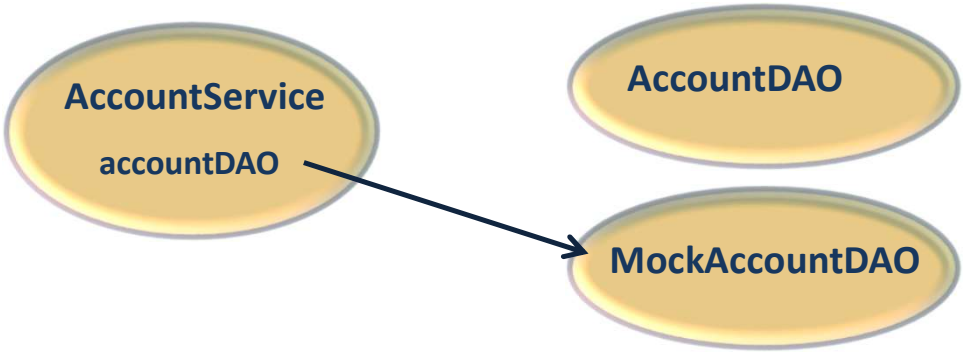
Change the wiring

```
<bean id="accountService" class="AccountService">
  <property name="accountDAO" ref="mockAccountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
<bean id="mockAccountDAO" class="MockAccountDAO" />
```

1. Spring instantiates all beans in the XML configuration file



2. Spring then connects the accountDAO attribute to the MockAccountDAO instance



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Advantages of Dependency Injection

```
public class AccountService {
  private IAccountDAO accountDAO;

  public void setAccountDAO(IAccountDAO accountDAO) {
    this.accountDAO = accountDAO;
  }
}
```

```
<bean id="accountService" class="AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
```

- Flexibility: it is easy to change the wiring between objects without changing code
- Unit testing becomes easier
- Code is clean

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Main point

- With dependency injection the framework wires objects together.

  Science of Consciousness: Everything in creation is connected at the level of the Unified Field.

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DIFFERENT TYPES OF DI

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Types of DI

- Setter injection
- Constructor injection
- Autowiring

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Setter Injection

```
public class AccountService {
  private IAccountDAO accountDAO;

  public void setAccountDAO(IAccountDAO accountDAO) {
    this.accountDAO = accountDAO;
  }
}
```

A setter method is needed

```
<bean id="accountService" class="AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
```

Use <property …/>

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Constructor Injection

```
public class AccountService {
  private IAccountDAO accountDAO;

  public AccountService(IAccountDAO accountDAO) {
    this.accountDAO = accountDAO;
  }
}
```

A constructor is needed to set accountDAO

```
<bean id="accountService" class="AccountService">
  <constructor-arg  ref="accountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
```

Use <constructor-arg …/>

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Constructor with multiple parameters

```
public class PaymentService implements IPaymentService{
  private IVisaVerifier visaVerifier;
  private IMastercardVerifier mastercardVerifier;

  public PaymentService(IVisaVerifier visaVerifier, IMastercardVerifier mastercardVerifier){
    this.visaVerifier=visaVerifier;
    this.mastercardVerifier=mastercardVerifier;
  }
}
```

Constructor has 2 arguments of a different type

```
<bean id="paymentService" class="products.PaymentService">
    <constructor-arg   ref="visaVerifier" />
    <constructor-arg   ref="mastercardVerifier" />
</bean>
<bean id="visaVerifier" class="products.VisaVerifier"/>
<bean id="mastercardVerifier"  class="products.MastercardVerifier"/>
```

Spring looks at the type of the argument to decide what to inject for the first and the second parameter

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Constructor with multiple parameters of the same type

```
public class PaymentService implements IPaymentService{
  private ICreditCardVerifier visaVerifier;
  private ICreditCardVerifier mastercardVerifier;

  public PaymentService(ICreditCardVerifier visaVerifier, ICreditCardVerifier mastercardVerifier){
    this.visaVerifier=visaVerifier;
    this.mastercardVerifier=mastercardVerifier;
  }
}
```

Constructor has 2 arguments of the same type

```
<bean id="paymentService" class="products.PaymentService">
    <constructor-arg   ref="visaVerifier" />
    <constructor-arg   ref="mastercardVerifier" />
</bean>
<bean id="visaVerifier" class="products.VisaVerifier"/>
<bean id="mastercardVerifier"  class="products.MastercardVerifier"/>
```

Spring looks at the order of declaration to decide what to inject for the first and the second parameter

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Constructor with multiple parameters of the same type

```
public class PaymentService implements IPaymentService{
  private ICreditCardVerifier visaVerifier;
  private ICreditCardVerifier mastercardVerifier;

  public PaymentService(ICreditCardVerifier visaVerifier, ICreditCardVerifier mastercardVerifier){
    this.visaVerifier=visaVerifier;
    this.mastercardVerifier=mastercardVerifier;
  }
}
```

Constructor has 2 arguments of the same type

```
<bean id="paymentService" class="products.PaymentService">
    <constructor-arg  index="0"  ref="visaVerifier" />
    <constructor-arg  index="1"  ref="mastercardVerifier" />
</bean>
<bean id="visaVerifier" class="products.VisaVerifier"/>
<bean id="mastercardVerifier"   class="products.MastercardVerifier"/>
```

Spring looks at the index to decide what to inject for the first and the second parameter

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Setter injection characteristics

- Order of execution:
  1. Instantiate the object
  2. Call the constructor
  3. Do the injection calling the setter method(s)
- Issues:
  - If the injection fails, you have an object in an invalid state
  - If you want to execute initialization code that uses the injected attributes, then you cannot place this code in the constructor, you need to write a separate init() method

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Constructor injection characteristics

- Order of execution:
  1. Instantiate the object
  2. Call the constructor and do the injection
- Issues:
  - You need constructor chaining with inheritance
  - In case of optional parameters you need multiple constructors

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Which one to choose?

- This is a more personal preference.
- If you need the injected attributes in the constructor, use constructor injection or use setter injection with an additional init() method.
- If constructor injection results in many different constructors, use setter injection for the optional arguments.

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Autowiring

- Spring figures out how to wire beans together
- 3 types of autowiring
  - By name
  - By Type
  - Constructor

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Autowiring by name

```java
public class CustomerService {
  private EmailService emailService;

  public void addCustomer(){
    emailService.sendEmail();
  }

  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }
}
```

Autowire by name uses setter injection, so we need a setter method

```java
public class EmailService {

  public void sendEmail(){
    System.out.println("sendEmail");
  }
}
```

Spring will inject the bean with id="emailService" into the attribute 'emailService'

```xml
<bean id="customerService" class="mypackage.CustomerService" autowire="byName"/>
<bean id="emailService" class="mypackage.EmailService"/>
```


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Autowiring by type

```
public class CustomerService {
  private EmailService emailService;

  public void addCustomer(){
    emailService.sendEmail();
  }

  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }
}
```

Autowire by type uses setter injection, so we need a setter method

```
public class EmailService {

  public void sendEmail(){
    System.out.println("sendEmail");
  }
}
```

Spring will inject the bean with type EmailService" into the attribute 'emailService'

```
<bean id="customerService" class="mypackage.CustomerService" autowire="byType"/>
<bean id="eService" class="mypackage.EmailService"/>
```


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Constructor autowiring

```java
public class CustomerService {
  private EmailService emailService;

  public CustomerService(EmailService emailService) {
    this.emailService = emailService;
  }

  public void addCustomer(){
    emailService.sendEmail();
  }
}
```

The constructor has 1 attribute of type EmailService

```java
public class EmailService {

  public void sendEmail(){
    System.out.println("sendEmail");
  }
}
```

Spring will inject the bean with type EmailService" into the attribute 'emailService'

```
<bean id="customerService" class="mypackage.CustomerService" autowire="constructor"/>
<bean id="eService" class="mypackage.EmailService"/>
```


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Annotation based Autowiring by constructor

```java
public class CustomerService {
  private EmailService emailService;

  @Autowired
  public CustomerService(EmailService emailService) {
    this.emailService = emailService;
  }

  public void addCustomer(){
    emailService.sendEmail();
  }
}
```

@Autowire indicates to Spring that the emailService attribute should be injected by type via the constructor

```java
public class EmailService {

  public void sendEmail(){
    System.out.println("sendEmail");
  }
}
```

This tag tells Spring to look for configuration annotations in the declared beans

```xml
<context:annotation-config/>
<bean id="customerService" class="mypackage.CustomerService"/>
<bean id="eService" class="mypackage.EmailService"/>
```


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Annotation based Autowiring by type

```
public class CustomerService {
  private EmailService emailService;

  @Autowired
  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }

  public void addCustomer(){
    emailService.sendEmail();
  }
}
```

@Autowire indicates to Spring that the emailService attribute should be injected by type via the setter method

```
public class EmailService {

  public void sendEmail(){
    System.out.println("sendEmail");
  }
}
```

This tag tells Spring to look for configuration annotations in the declared beans

```
<context:annotation-config/>
<bean id="customerService" class="mypackage.CustomerService"/>
<bean id="eService" class="mypackage.EmailService"/>
```


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Field injection

```java
public class CustomerService {
  @Autowired
  @Qualifier("myEmailService")
  private EmailService emailService;

  public void addCustomer(){
    emailService.sendEmail();
  }
}
```

autowire by name

```java
public class EmailService {

  public void sendEmail(){
    System.out.println("sendEmail");
  }
}
```

```xml
<context:annotation-config/>
<bean id="customerService" class="mypackage.CustomerService"/>
<bean id="myEmailService" class="mypackage.EmailService"/>
```


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Field injection

```
public class CustomerService {
  @Autowired
  private EmailService emailService;

  public void addCustomer(){
    emailService.sendEmail();
  }
}
```

```
public class CustomerService {
  @Inject
  private EmailService emailService;

  public void addCustomer(){
    emailService.sendEmail();
  }
}
```


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Autowiring

- Advantage
  - Makes configuration of bean wiring simpler
- Disadvantages
  - The Spring XML file does not contain all the explicit details on how the beans are wired together
  - Autowire by type gives the restriction that you can have only 1 bean of the given type

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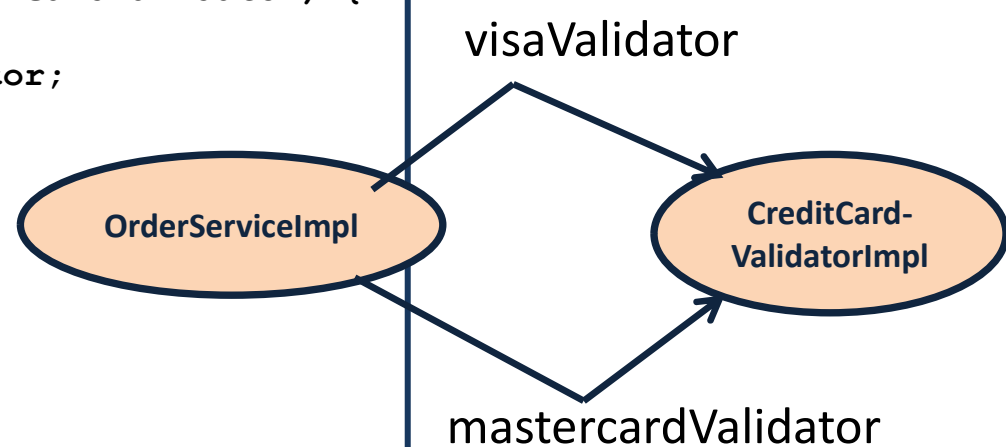
DI and singletons

```
public class OrderServiceImpl implements OrderService {
  private CreditCardValidator visaValidator;
  private CreditCardValidator mastercardValidator;

  public OrderServiceImpl(CreditCardValidator visaValidator,
                          CreditCardValidator mastercardValidator) {
   this.visaValidator = visaValidator;
   this.mastercardValidator = mastercardValidator;
  }

  public void payOrder(CreditCard card){
    if (card.getType().equals("visa")){
      visaValidator.validate(card);
    }
    else{
      if (card.getType().equals("mastercard")){
        mastercardValidator.validate(card);
      }
    }
  }
}
```




```
<bean id="orderService" class= "OrderServiceImpl">
  <constructor-arg  index="0"  ref="creditcardVerifier" />
  <constructor-arg  index="1"  ref="creditcardVerifier" />
</bean>
<bean id="creditcardVerifier" class="CreditCardValidatorImpl"/>
```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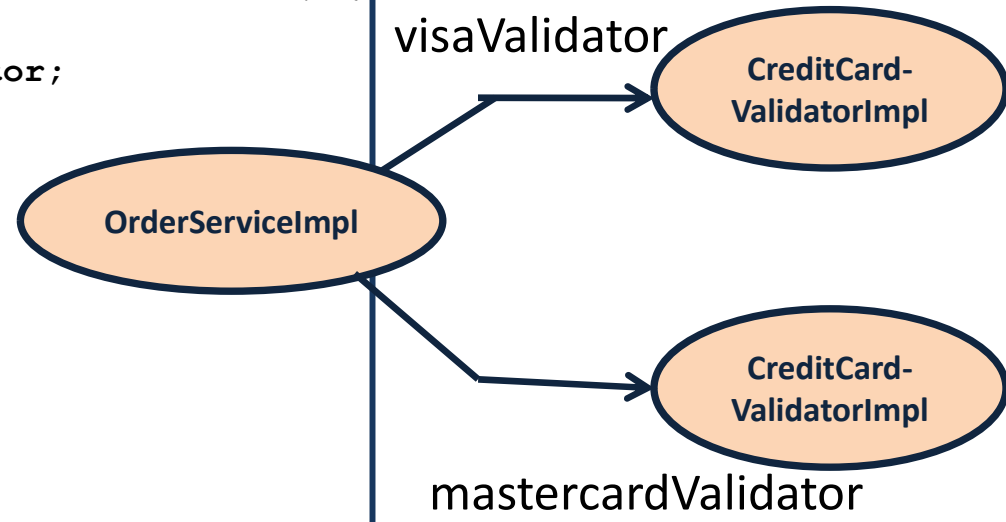
DI and prototypes

```
public class OrderServiceImpl implements OrderService {
  private CreditCardValidator visaValidator;
  private CreditCardValidator mastercardValidator;

  public OrderServiceImpl(CreditCardValidator visaValidator,
                          CreditCardValidator mastercardValidator) {
   this.visaValidator = visaValidator;
   this.mastercardValidator = mastercardValidator;
  }

  public void payOrder(CreditCard card){
    if (card.getType().equals("visa")){
      visaValidator.validate(card);
    }
    else{
      if (card.getType().equals("mastercard")){
        mastercardValidator.validate(card);
      }
    }
  }
}
```




```
<bean id="orderService" class= "OrderServiceImpl">
  <constructor-arg  index="0"  ref="creditcardVerifier" />
  <constructor-arg  index="1"  ref="creditcardVerifier" />
</bean>
<bean id="creditcardVerifier" class="CreditCardValidatorImpl" scope="prototype"/>
```

prototype

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Injection of primitive values

```
public class CustomerServiceImpl implements CustomerService {
  private String defaultCountry;
  private long numberOfCustomers;

  public void setDefaultCountry(String defaultCountry) {
    this.defaultCountry = defaultCountry;
  }
  public String getDefaultCountry() {
    return defaultCountry;
  }
  public long getNumberOfCustomers() {
    return numberOfCustomers;
  }
  public void setNumberOfCustomers(long numberOfCustomers) {
    this.numberOfCustomers = numberOfCustomers;
  }
}
```

```
<bean id="customerService" class="mypackage.CustomerServiceImpl">
  <property name="defaultCountry" value="USA"/>
  <property name="numberOfCustomers" value="56982"/>
</bean>
```

Automatic conversion from String to long

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DEPENDENCY INJECTION WITH CLASSPATH SCANNING

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Classpath scanning

- Define beans with annotations instead of defining them with XML
- All classes with the annotations
  - @Component
  - @Service
  - @Repository
  - @Controller

  become spring beans

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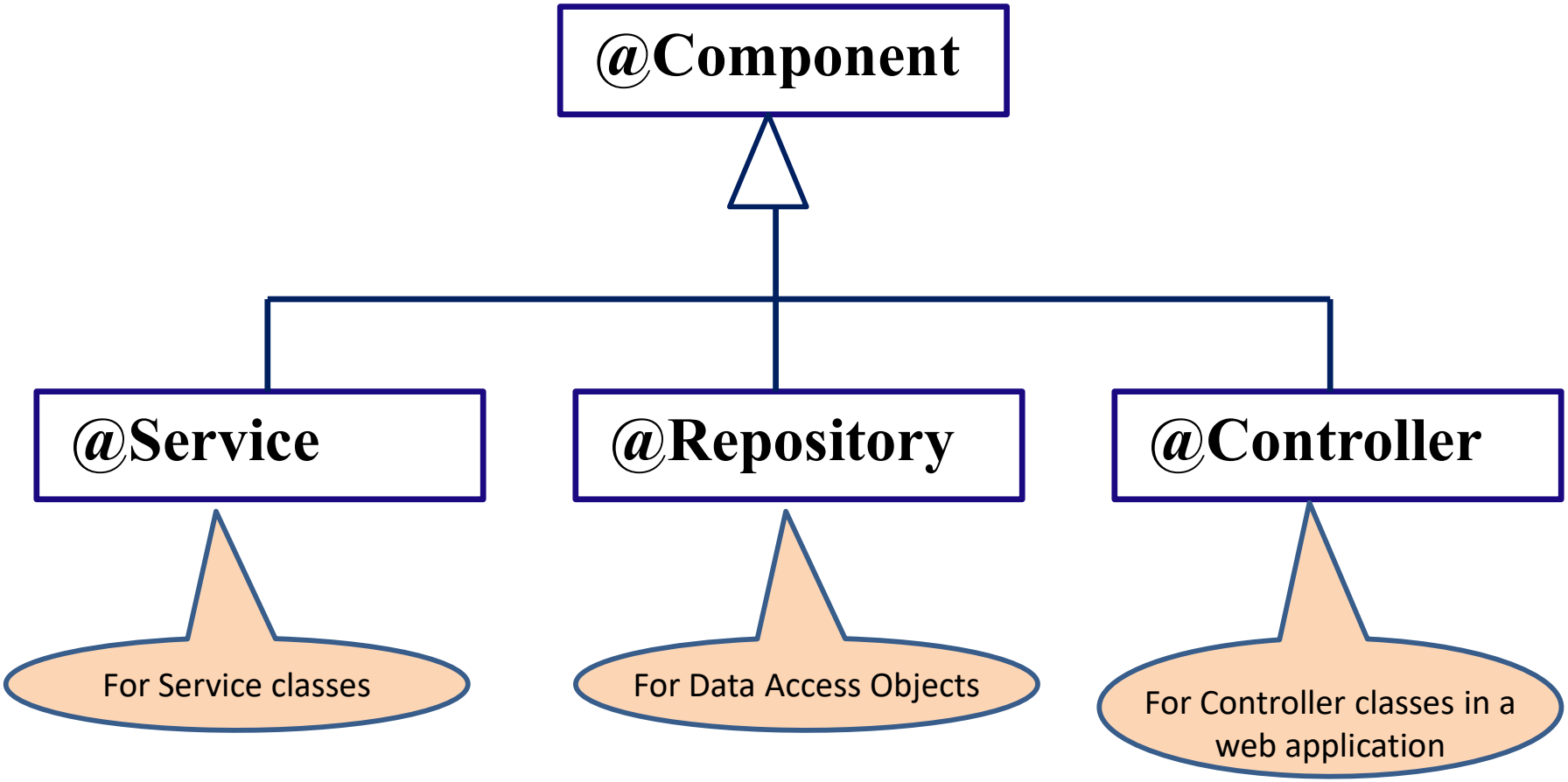
Classpath scanning annotations



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Classpath scanning example (1/2)

```
@Service ("customerService")
public class CustomerServiceImpl implements CustomerService{
private EmailService emailService;

  @Autowired
  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

@Service annotation

The EmailService is injected

```
@Service ("emailService")
public class EmailService implements IEmailService {

  public void sendEmail() {
    System.out.println("sendEmail");
  }
}
```

@Service annotation

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Classpath scanning example (2/2)

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

    <context:component-scan base-package="module3.classpathscanning.basic"/>

</beans>
```

No beans declared

```java
public class Application {
  public static void main(String[] args) {
    ApplicationContext context = new ClassPathXmlApplicationContext("springconfig.xml");
    CustomerService customerService = context.getBean("customerService", CustomerService.class);
    customerService.addCustomer();
  }
}
```


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@Scope for autodetect components

- The default scope is “singleton”

```
@Service ("emailService")
@Scope("prototype")
public class EmailServiceImpl implements EmailService{
public void sendEmail() {
    System.out.println("sendEmail");
  }
}
```

Set the scope to prototype

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@Value

```
@Service ("emailService")
public class EmailServiceImpl implements EmailService{
  @Value("smtp.mailserver.com")
  private String emailServer;

  public void sendEmail() {
    System.out.println("send email to server: "+ emailServer);
  }
}
```

Set the Value of an attribute

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DEPENDENCY INJECTION WITH JAVA CONFIGURATION

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Java Configuration

- Spring beans can also be configured in Java (and annotations) instead of XML

```
@Configuration
public class AppConfig {
  @Bean
  public CustomerService customerService(){
    CustomerService customerService = new CustomerServiceImpl();
    customerService.setEmailService(emailService());
    return customerService;
  }
  @Bean
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

Similar configuration

```
<bean id="customerService" class="module3.di.CustomerServiceImpl">
  <property name="emailService" ref="emailService"/>
</bean>
<bean id="emailService" class="module3.di.EmailServiceImpl" />
```


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Java configuration example (1/2)

```
public class CustomerServiceImpl implements CustomerService{
private EmailService emailService;

  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

```
public class EmailService implements IEmailService {

  public void sendEmail() {
    System.out.println("sendEmail");
  }
}
```


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Java configuration example (2/2)

```
@Configuration
public class AppConfig {
  @Bean
  public CustomerService customerService(){
    CustomerService customerService = new CustomerServiceImpl();
    customerService.setEmailService(emailService());
    return customerService;
  }
  @Bean
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

Create a bean with the name "customerService"

Set the property emailService

AnnotationConfigApplicationContext

```
public class Application {
  public static void main(String[] args) {
    ApplicationContext context = new AnnotationConfigApplicationContext(AppConfig.class);
    CustomerService customerService =
         context.getBean("customerService", CustomerService.class);

    customerService.addCustomer();
  }
}
```


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@Lazy

```
@Configuration
public class AppConfig {
  @Bean
  @Lazy(true)
  public CustomerService customerService(){
    return new CustomerServiceImpl();
  }
  @Bean
  @Lazy(true)
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

Lazy initialization

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@Scope

```
@Configuration
public class AppConfig {
  @Bean
  public CustomerService customerService(){
    return new CustomerServiceImpl();
  }

  @Bean
  @Scope(value="prototype")
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

Set scope to prototype

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Configuration in Configuration file(s) and in the Spring beans

```
@Configuration
public class AppConfig {
  @Bean
  public CustomerService customerService(){
    return new CustomerServiceImpl();
  }
  @Bean
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

Definition of 2 Spring beans

```
public class CustomerServiceImpl implements CustomerService{
  private EmailService emailService;

  @Autowired
  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

The EmailService is injected

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3 WAYS TO CONFIGURE SPRING APPLICATIONS

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3 ways of Spring configuration

- XML configuration
- Classpath scanning and Autowiring
- Java configuration

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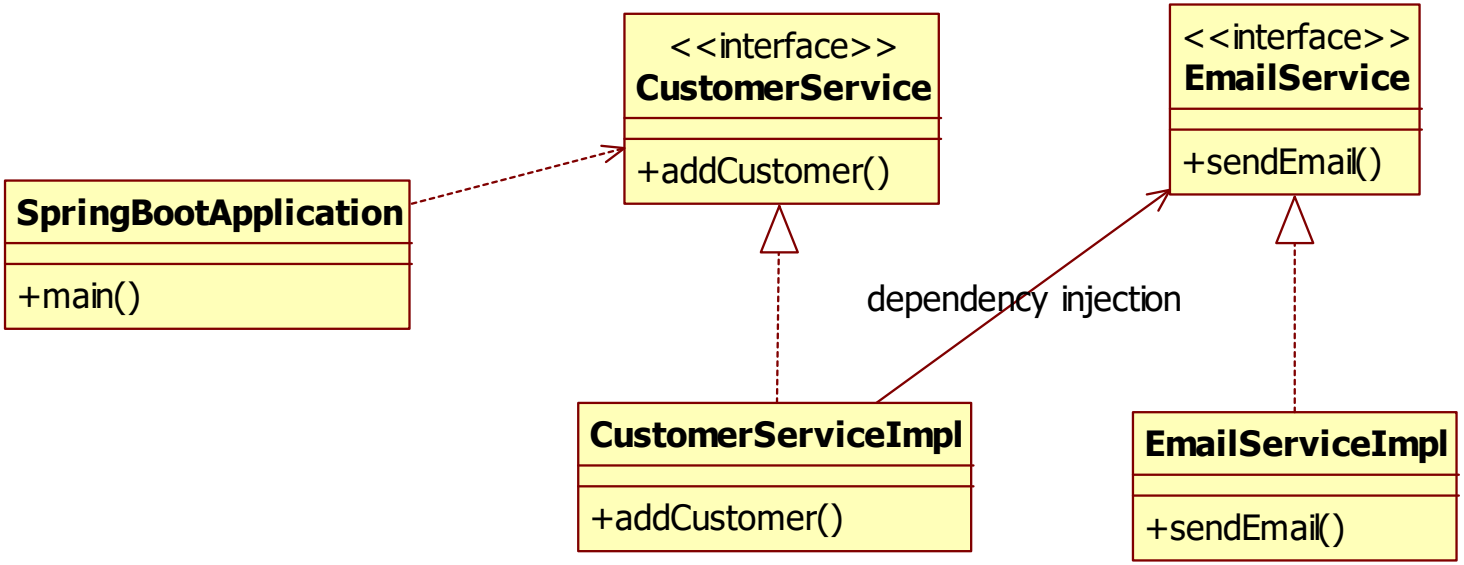
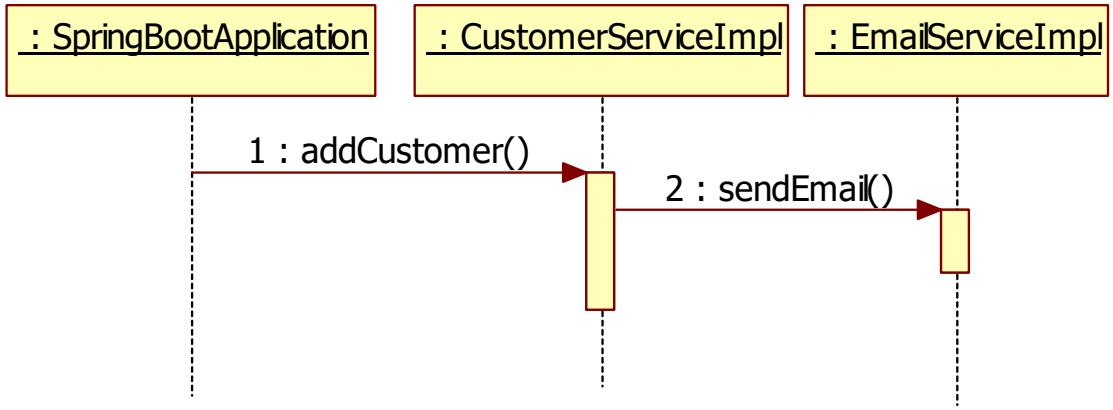
Example application





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The implementation

```java
public interface EmailService {
  void sendEmail();
}
```

```java
public class EmailServiceImpl implements EmailService{
  public void sendEmail() {
    System.out.println("Sending email");
  }
}
```

```java
public interface CustomerService {
  void addCustomer();
}
```

```java
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }
  public void addCustomer() {
    emailService.sendEmail();
  }
}
```


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Option 1: XML configuration

```xml
<bean id="customerService" class="xml.CustomerServiceImpl">
  <property name="emailService" ref="emailService" />
</bean>
<bean id="emailService" class="xml.EmailServiceImpl" />
```


```java
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }
  public void addCustomer() {
    emailService.sendEmail();
  }
}
```


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XML configuration

- Advantages
  - Configuration separate from Java code
  - All configuration in one place
  - Tools can use the XML for graphical views
  - Easy to change the configuration

- Disadvantages
  - Large verbose XML file(s)
  - No compile time type safety
  - Less refactor-friendly

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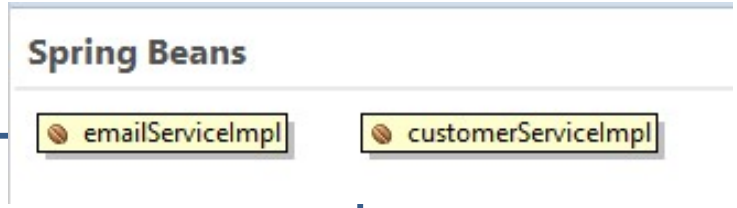
Option 2: Classpath scanning and Autowiring




```
<context:component-scan base-package="scanning"/>
<context:annotation-config />
```

```
@Service
public class CustomerServiceImpl implements CustomerService {
  @Autowired
  private EmailService emailService;

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```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Classpath scanning and Autowiring

- Advantages
  - All information (configuration and logic) in one place: the Java code
  - Simpler as XML
  - More type safe
- Disadvantage
  - Configuration in the Java code
  - Configuration is harder to change
    - Not a clear overview
    - You have to recompile

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Option 3: Java configuration

```java
@Configuration
public class AppConfig {
  @Bean
  public CustomerService customerService(){
    CustomerService customerService = new CustomerServiceImpl();
    customerService.setEmailService(emailService());
    return customerService;
  }
  @Bean
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

```java
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }
  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

Java configuration

- Advantages
  - Configuration separate from Java code
  - Simpler as XML
  - Type safe
- Disadvantage
  - Requires a little bit more code
  - Configuration is harder to change
    - Not a clear overview
    - You have to recompile

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Simpler configuration

- Java config + autowiring

```
@Configuration
public class AppConfig {
  @Bean
  public CustomerService customerService(){
    return new CustomerServiceImpl();
  }
  @Bean
  public EmailService emailService(){
    return new EmailServiceImpl();
  }
}
```

```
public class CustomerServiceImpl implements CustomerService {
  @Autowired
  private EmailService emailService;

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```


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Simplest Configuration!

- Java config + classpath scanning + autowiring

```
@Configuration
@ComponentScan
public class AppConfig {
}
```

```
@Service
public class CustomerServiceImpl implements CustomerService {
  @Autowired
  private EmailService emailService;

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

```
@Service
public class EmailServiceImpl implements EmailService{
  public void sendEmail() {
    System.out.println("Sending email");
  }
}
```

Main point

- The Spring configuration tells the Spring framework which classes to instantiate and which classes to connect to each other with dependency injection.

  Science of Consciousness: Nature is configured in such a way that it always takes the path of least action.

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Connecting the parts of knowledge with the wholeness of knowledge

1. Spring instantiates all Spring beans and wires them together with dependency injection
2. The simplest way to configure a Spring application is with Java config + classpath scanning + autowiring

3. **Transcendental consciousness** is the direct experience of pure consciousness, the unified field of all the laws of nature.
4. **Wholeness moving within itself:** In unity consciousness, one appreciates the inherent underlying unity that underlies all the diversity of creation.

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