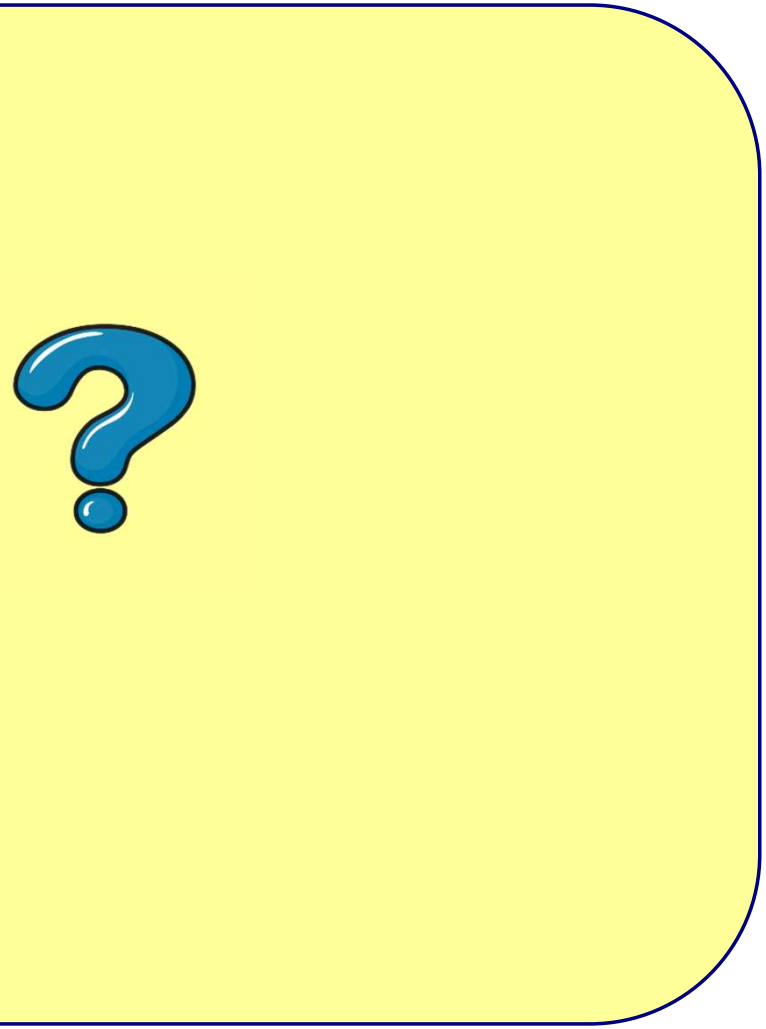
CS544

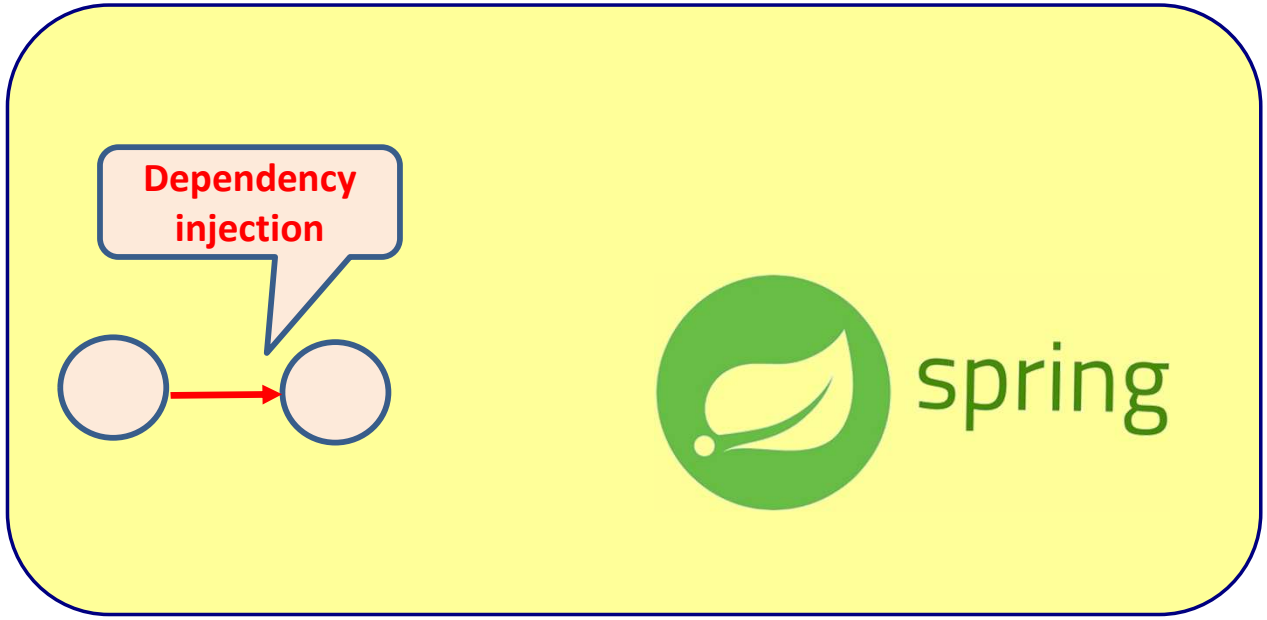
ENTERPRISE APPLICATIONS

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
April 3 **Lesson 1** Introduction Spring framework Dependency injection	April 4 **Lesson 2** Spring Boot AOP	April 5 **Lesson 3** JDBC JPA	April 6 **Lesson 4** JPA mapping 1	April 7 **Lesson 5** JPA mapping 2	April 8 **Lesson 6** JPA queries	April 9
April 10 **Lesson 7** Transactions	April 11 **Lesson 8** MongoDB	April 12 **Midterm Review**	April 13 **Midterm exam**	April 14 **Lesson 9** REST webservices	April 15 **Lesson 10** SOAP webservices	April 16
April 17 **Lesson 11** Messaging	April 18 **Lesson 12** Scheduling Events Configuration	April 19 **Lesson 13** Monitoring	April 20 **Lesson 14** Testing your application	April 21 **Final review/Project**	April 22 **Project**	April 23
April 24 **Final exam**	April 25 **Project**	April 26 **Project**	April 27 **Class celebration**			

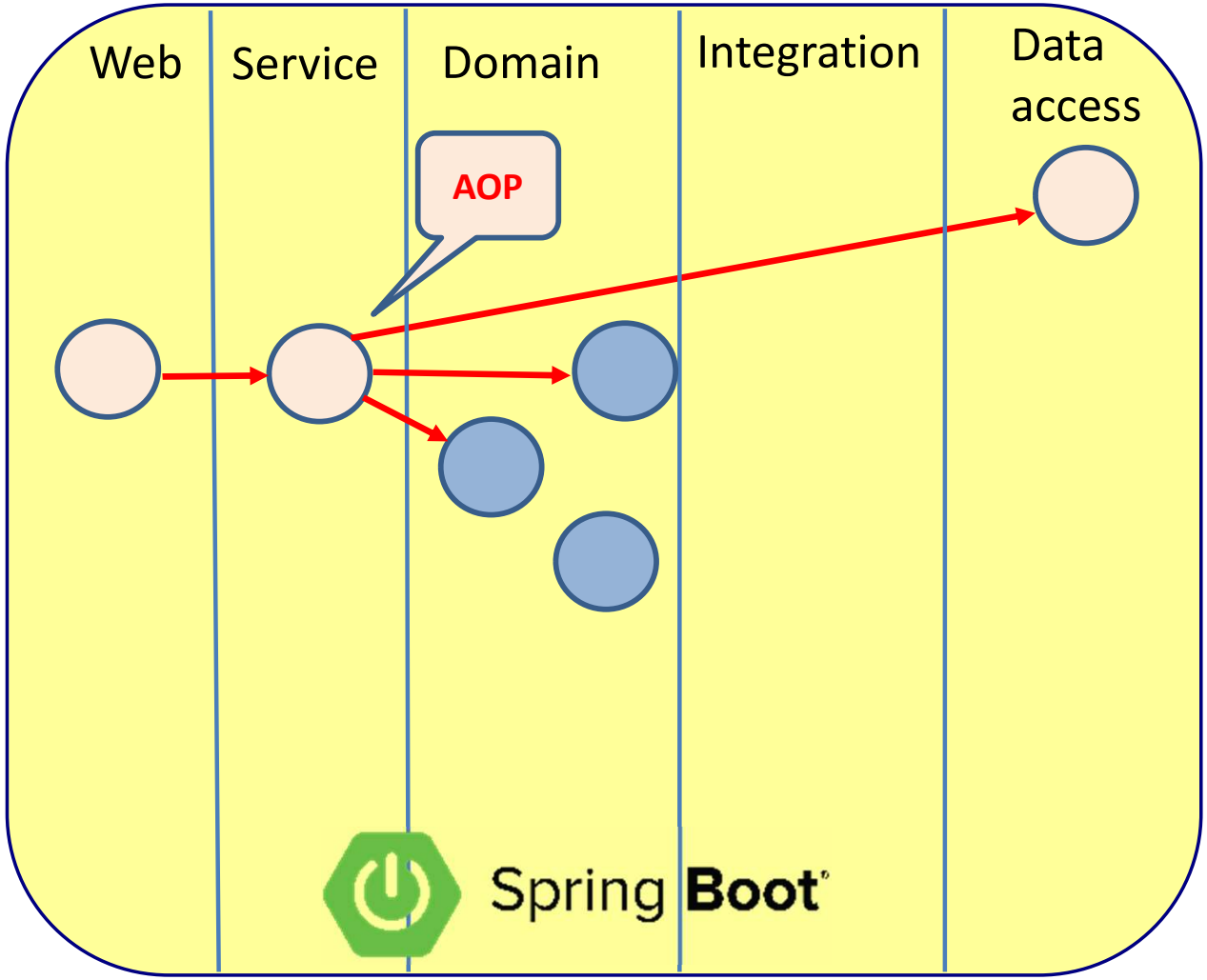
Enterprise Application Architecture



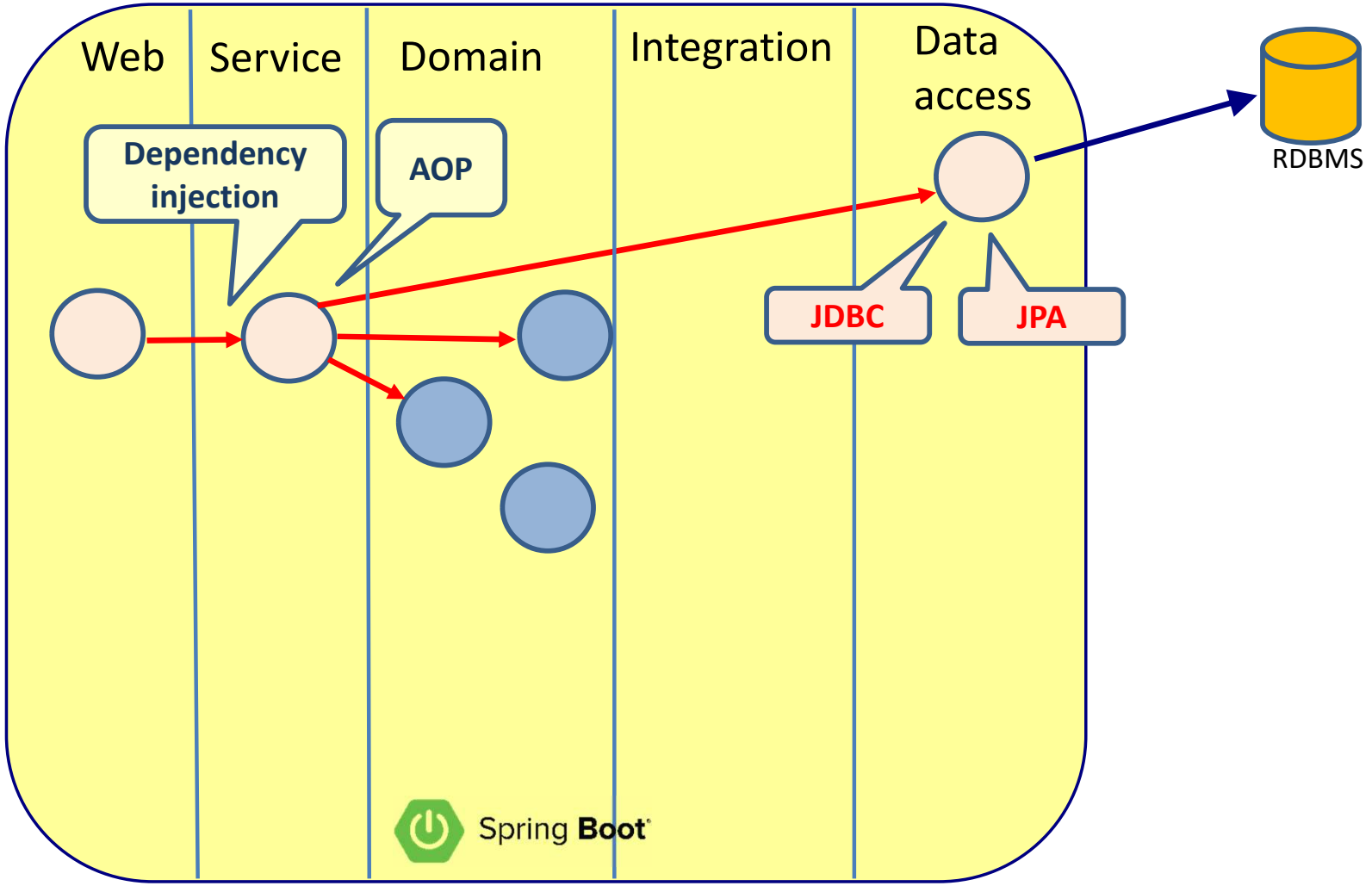
Lesson 1: Introduction to Spring



Lesson 2


Web
Service
Domain
Integration
Data access
AOP
Spring Boot

Lesson 3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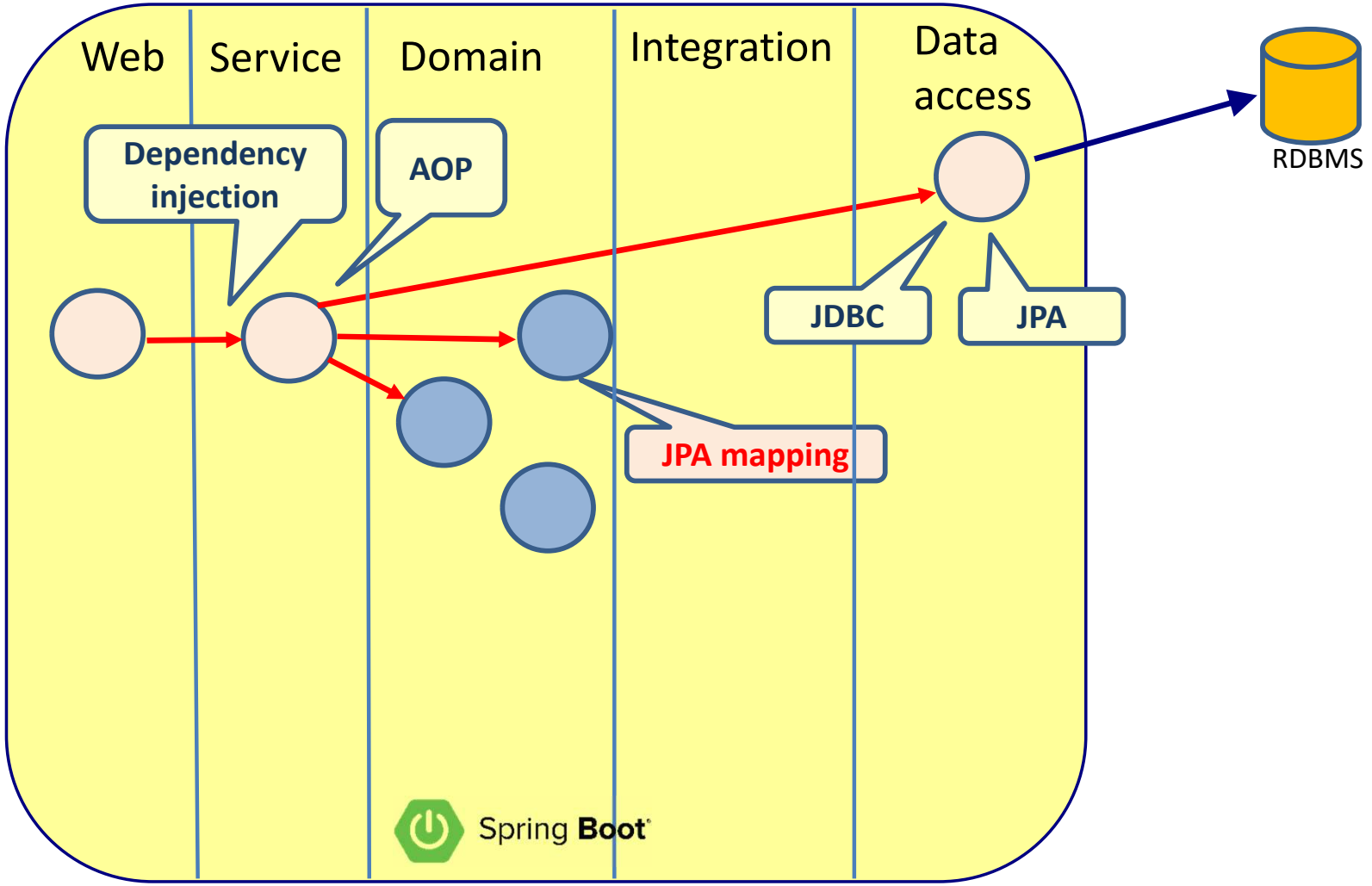
JPA
RDBMS
Spring Boot

Lesson 4+5


Web
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JPA mapping
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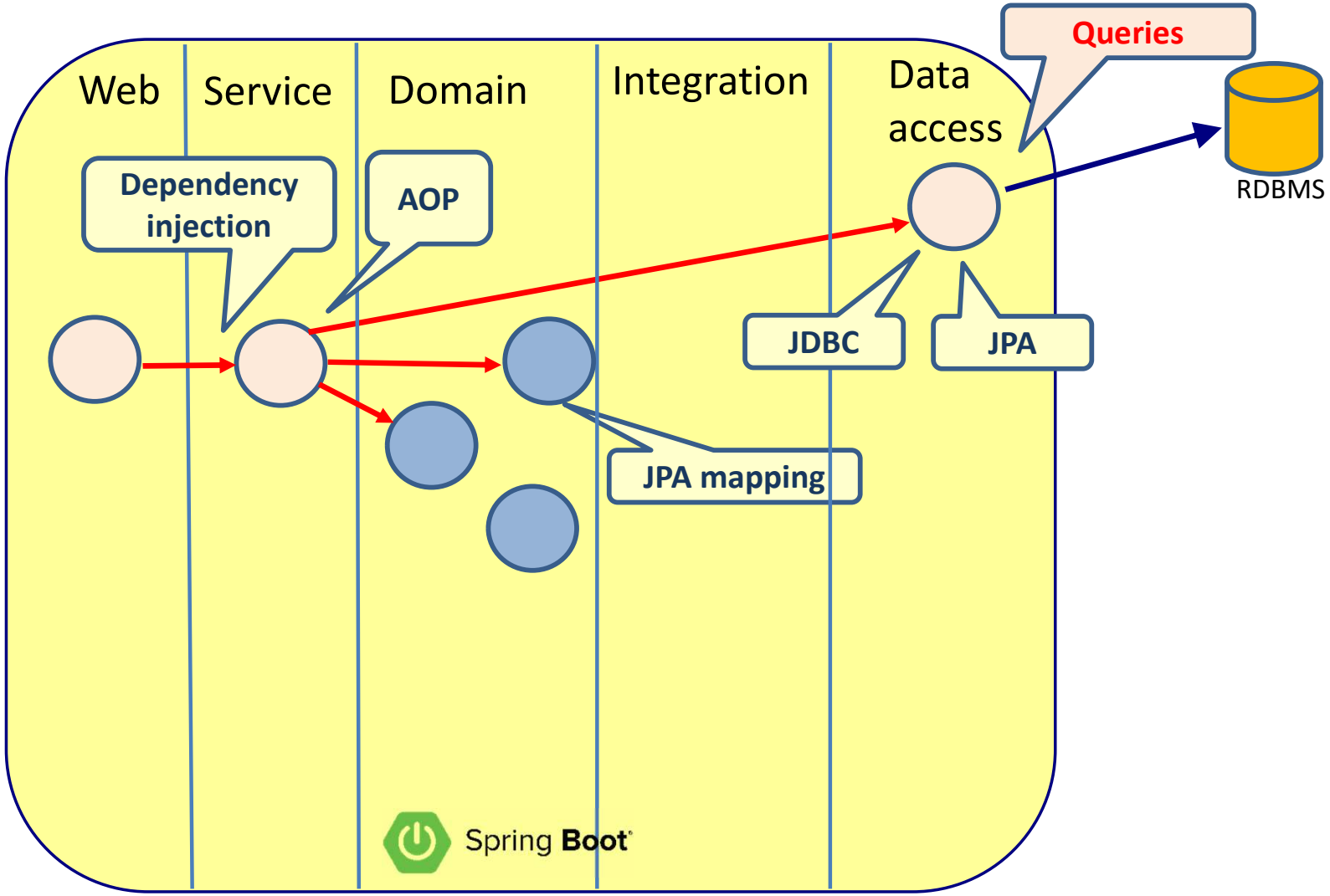
Spring Boot

Lesson 6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Dependency injection
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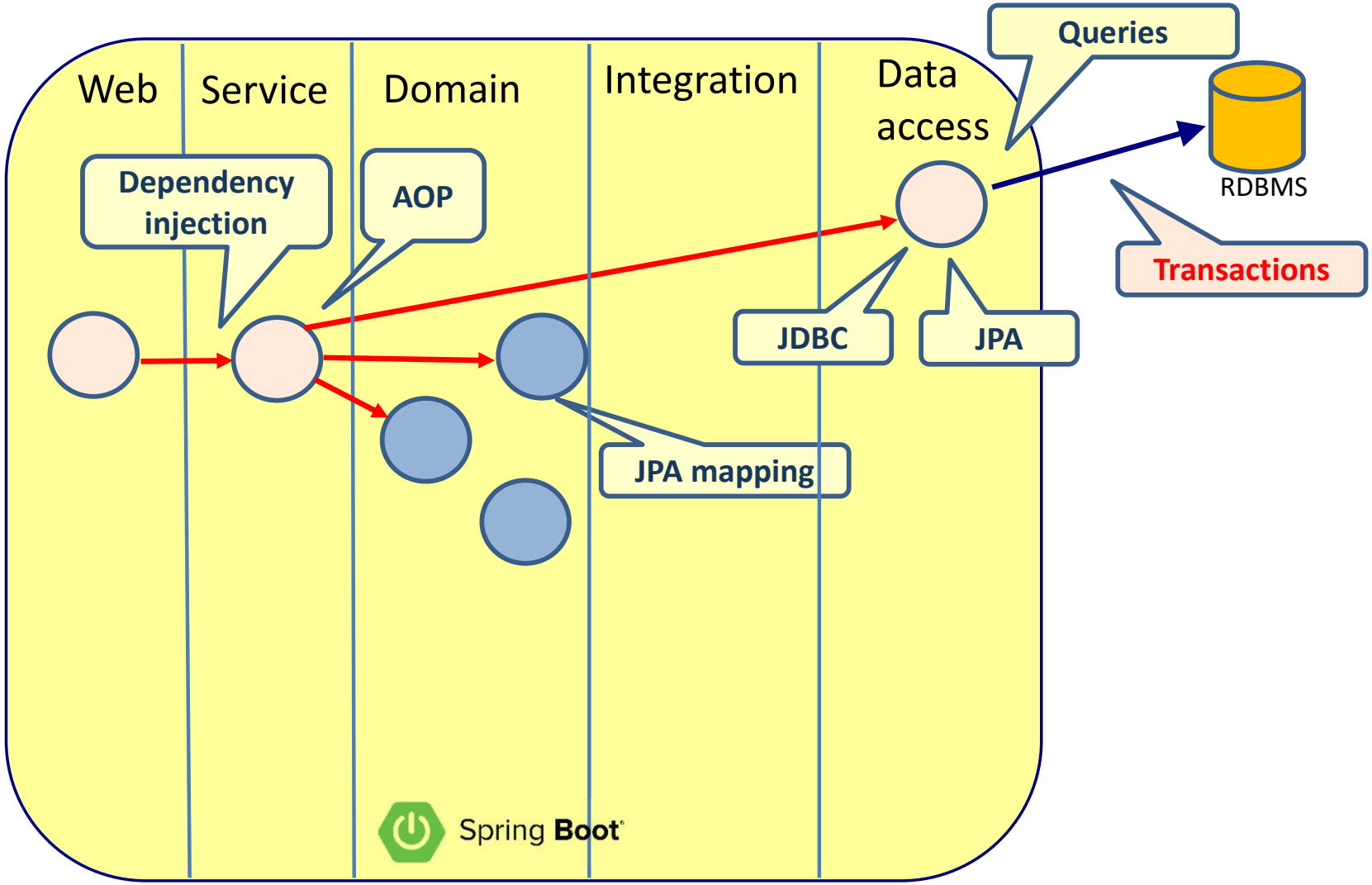
JPA mapping
Spring Boot

Lesson 7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Dependency injection
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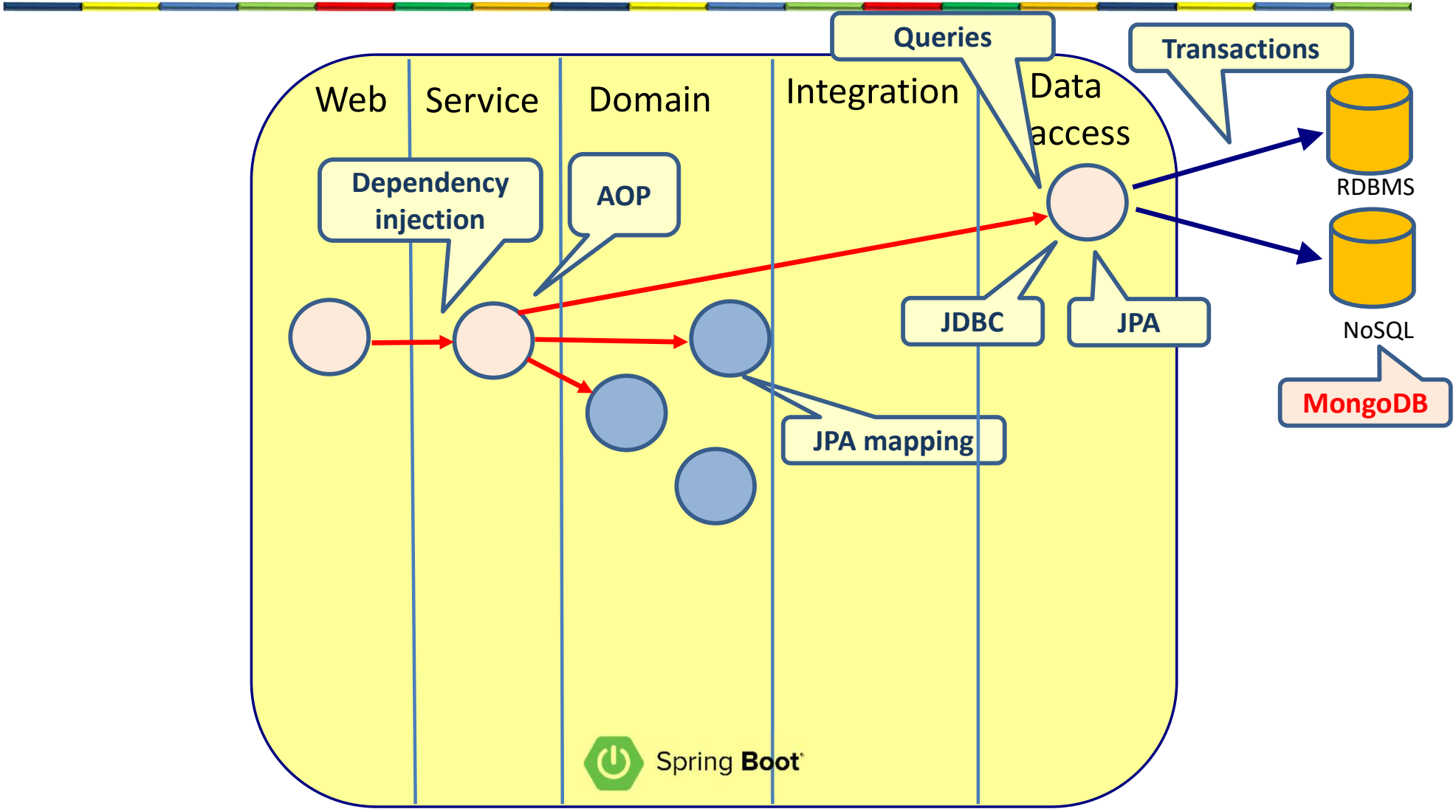
JPA
JPA mapping
Spring Boot

Lesson 8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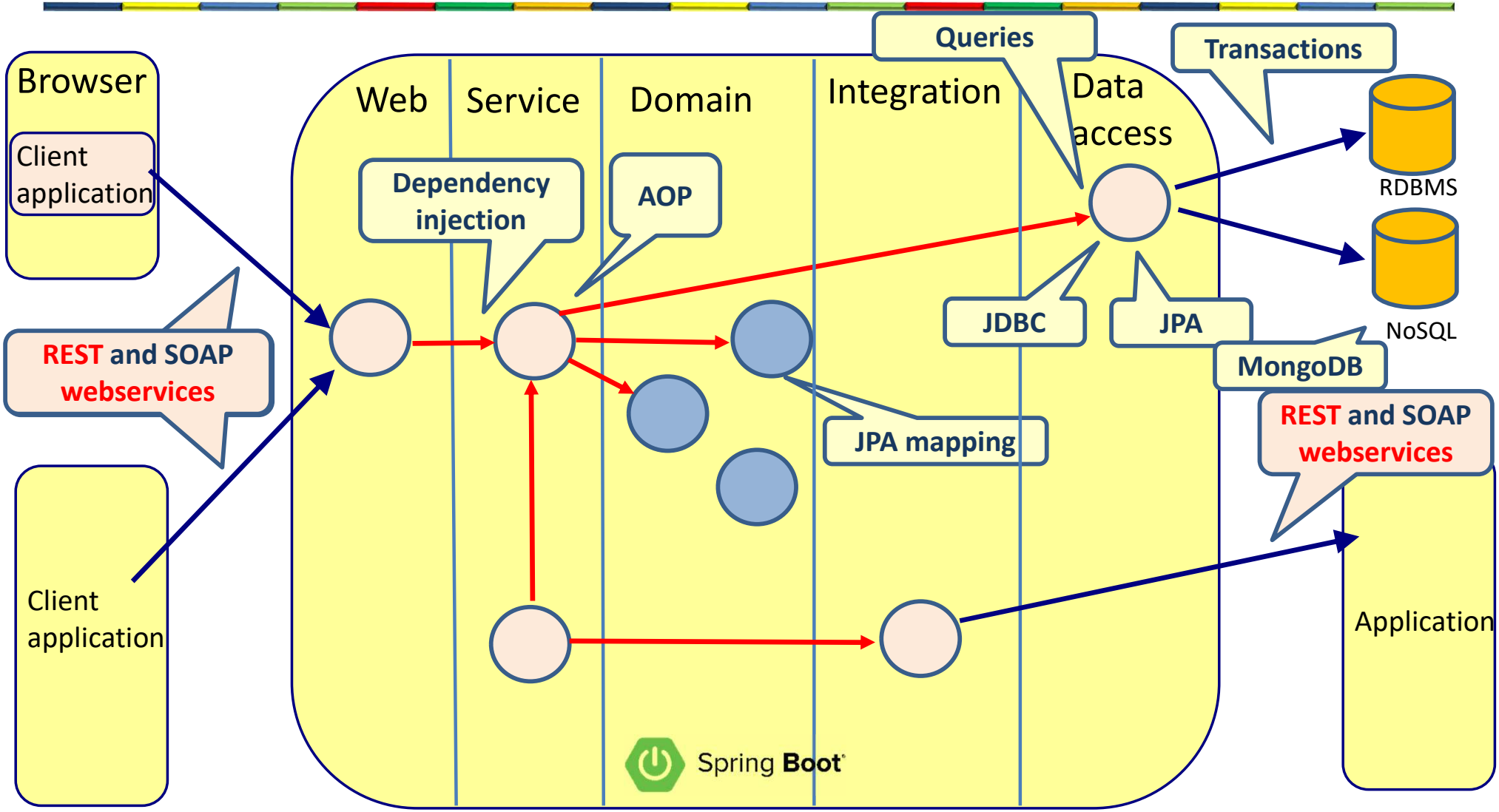
Lesson 9


Browser
Client application
REST and SOAP webservices
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JPA
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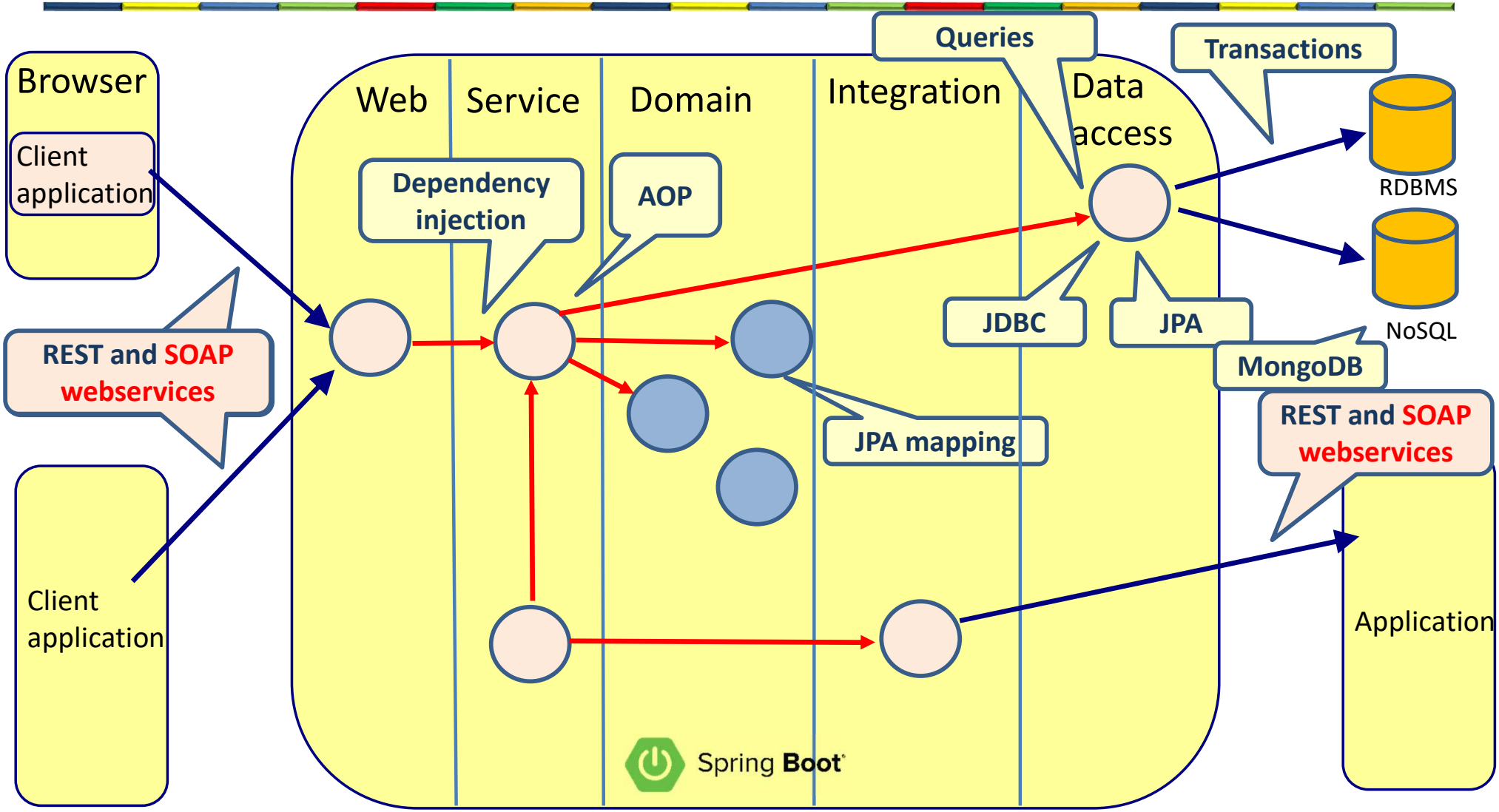
NoSQL
MongoDB
REST and SOAP webservices
Application
Spring Boot

Lesson 10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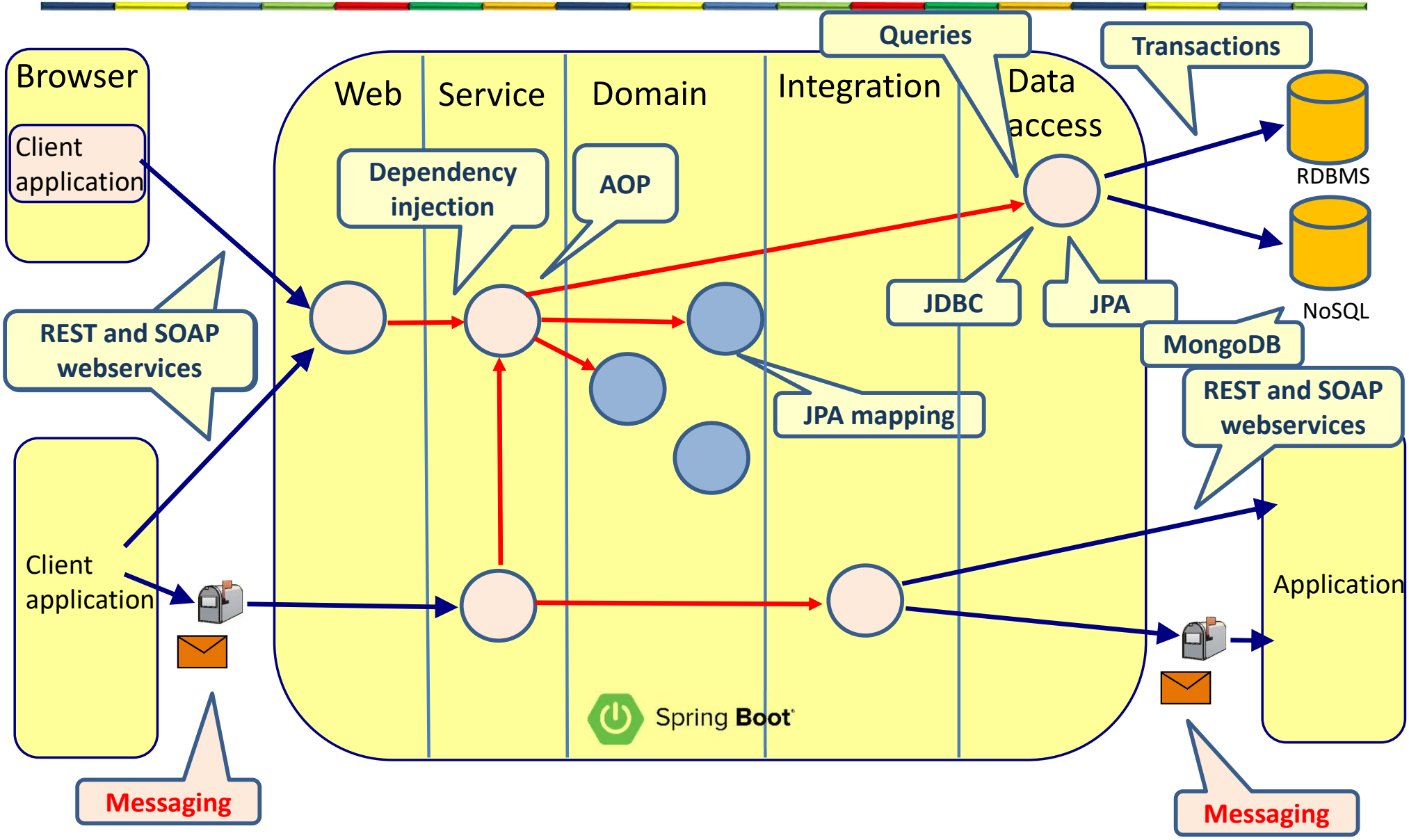
Lesson 11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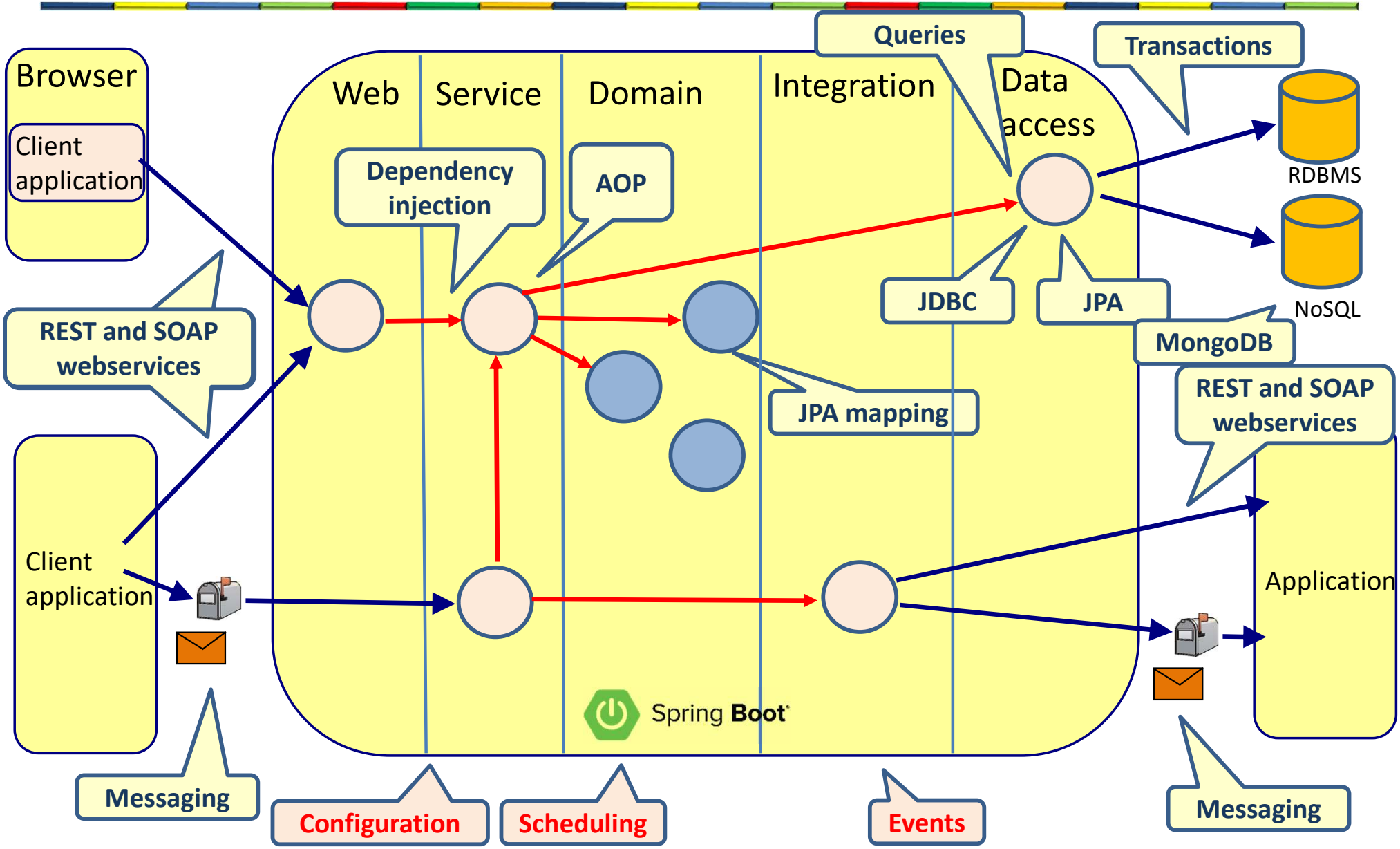
REST and SOAP webservices
JPA mapping
REST and SOAP webservices
Client application
Application
Spring Boot
Messaging
Messaging

Lesson 12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Client application
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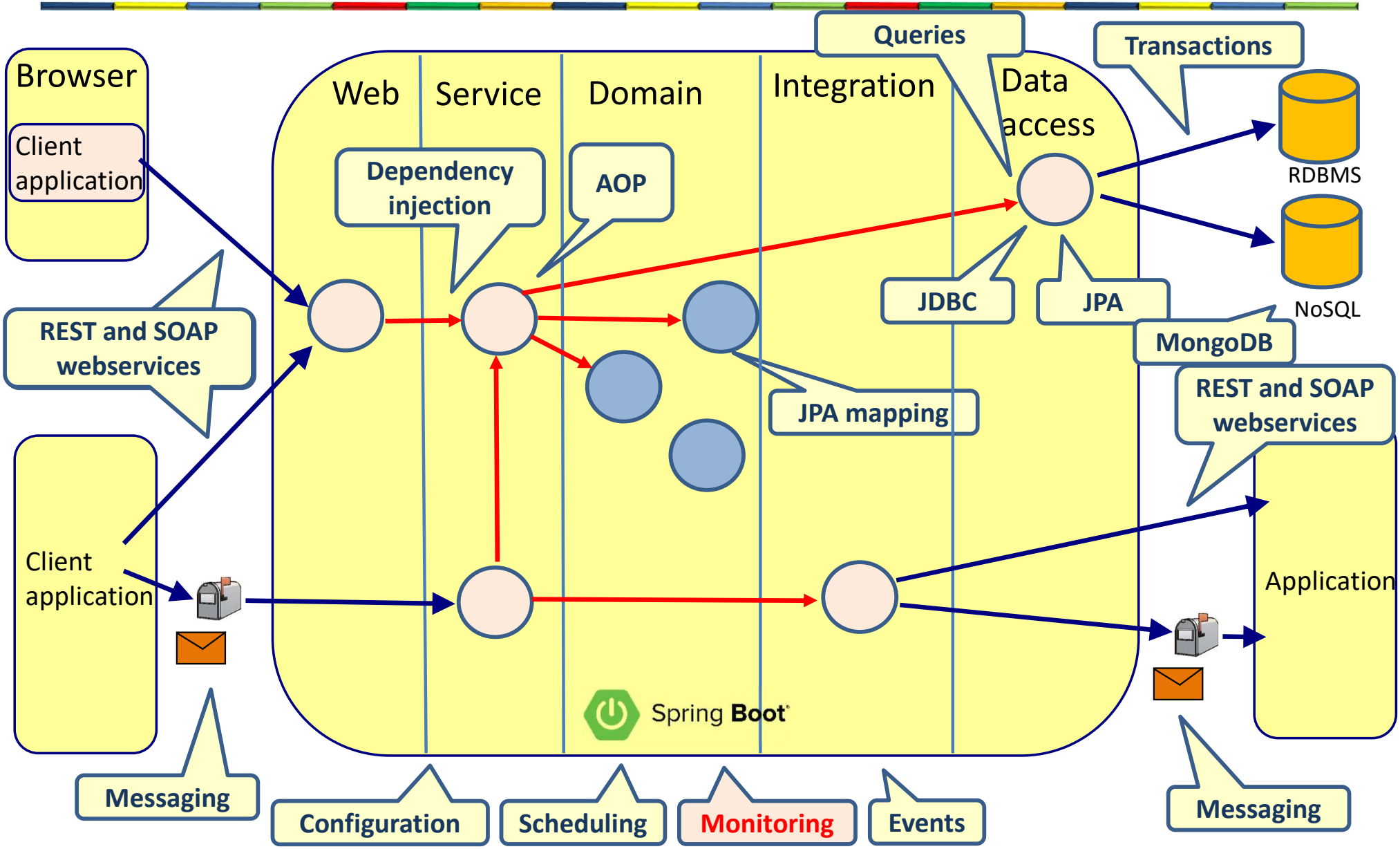
Messaging
Configuration
Scheduling
Events
Messaging

Lesson 13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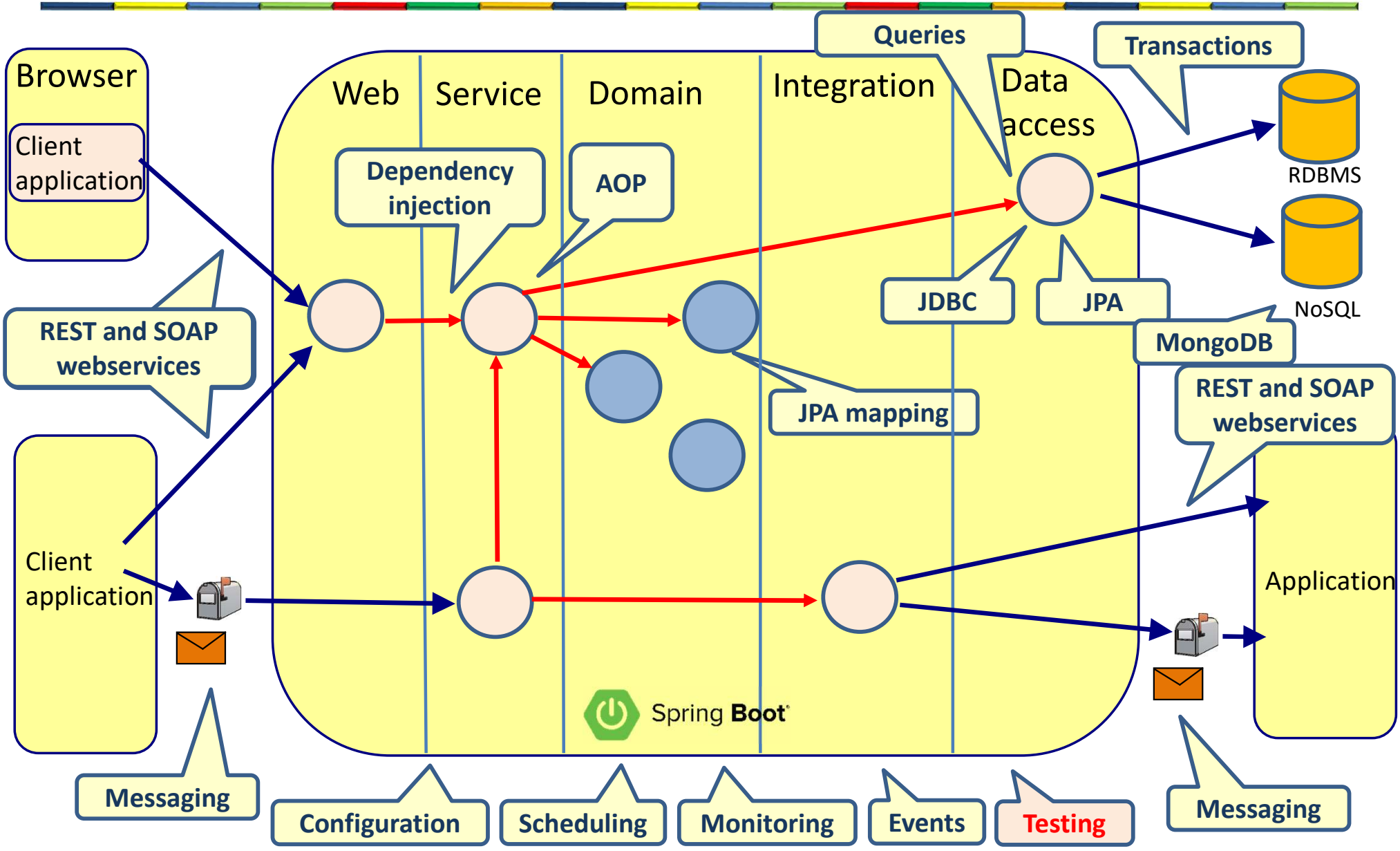
Lesson 14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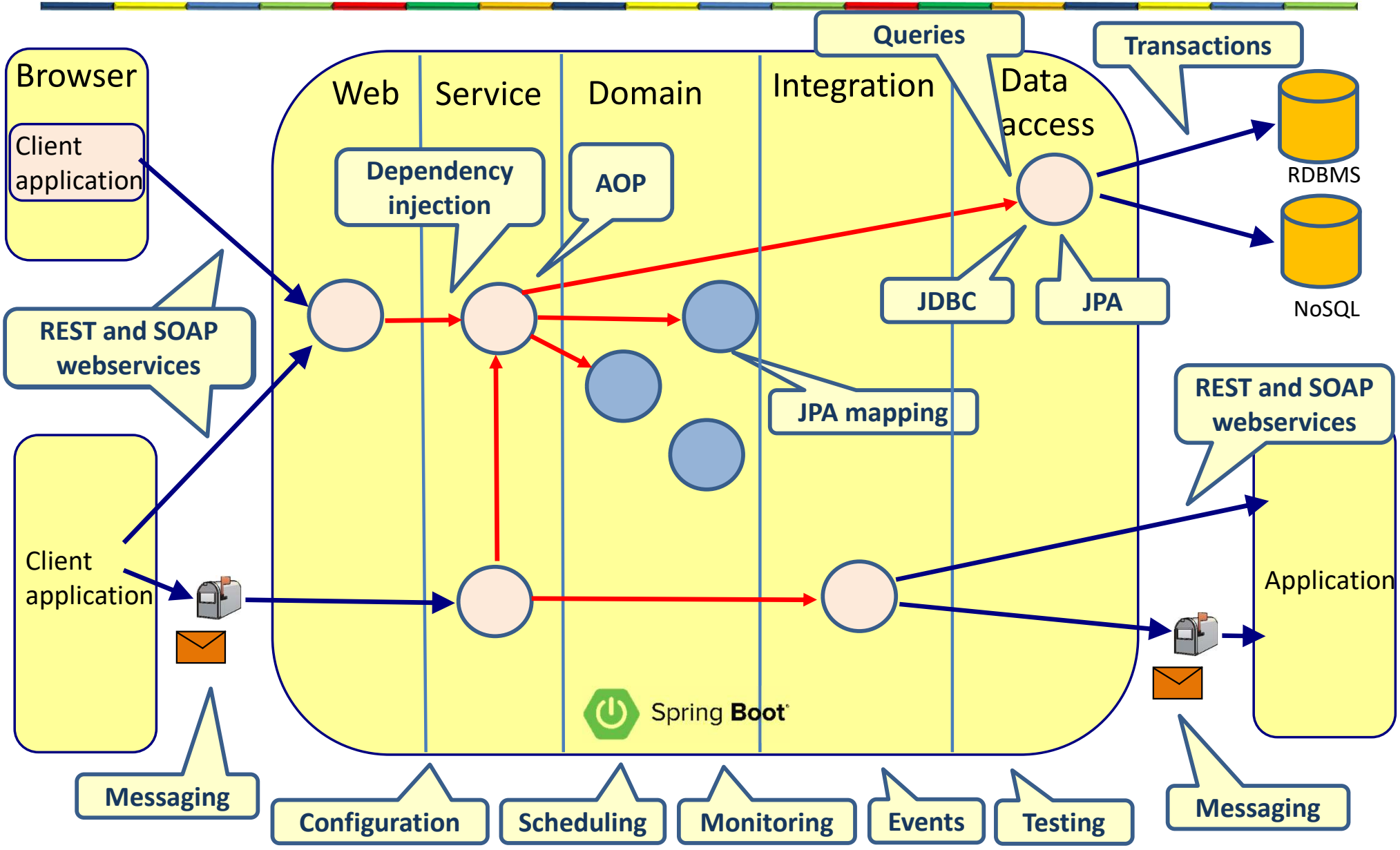
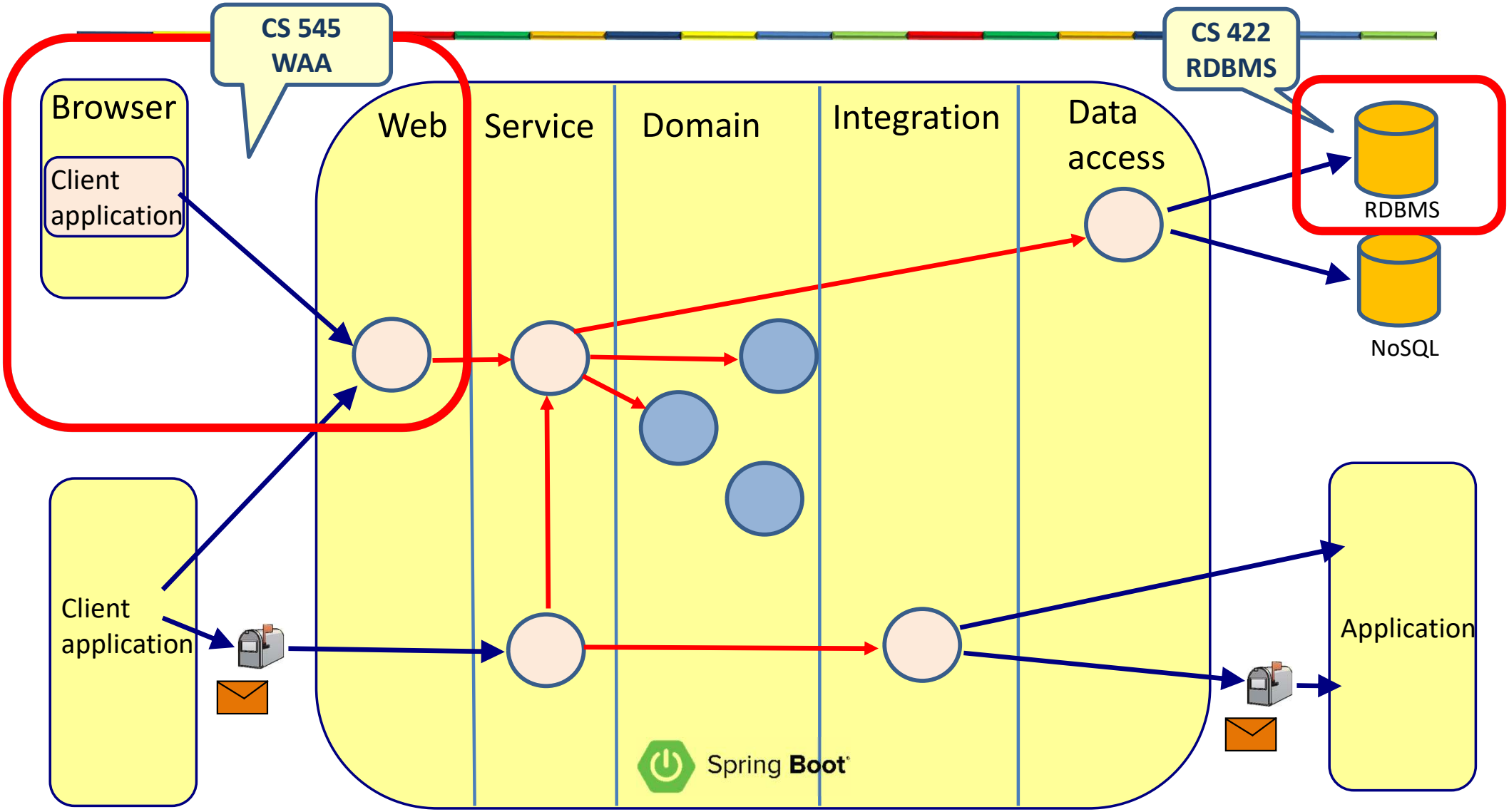
Enterprise Application Architecture



Connection with other courses



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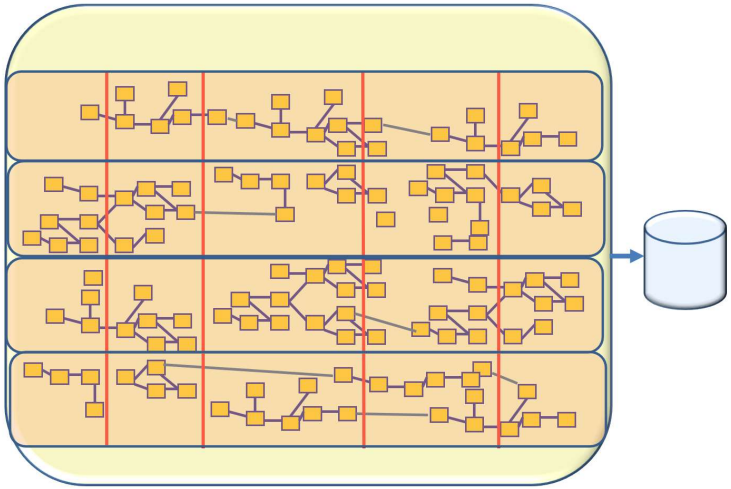
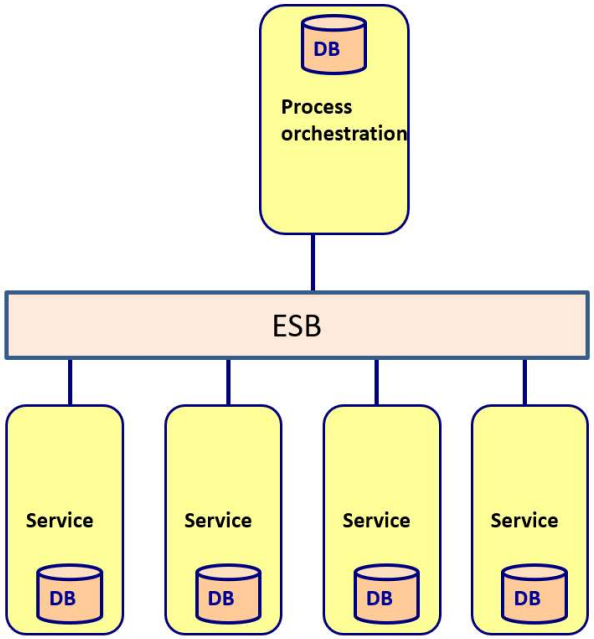
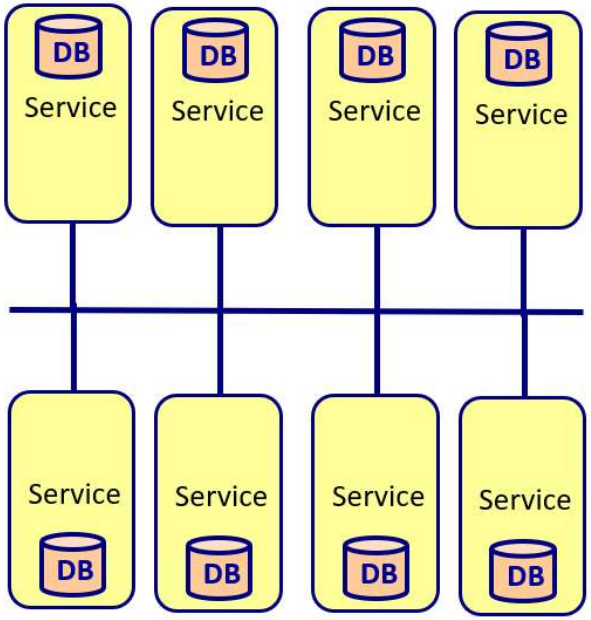


components



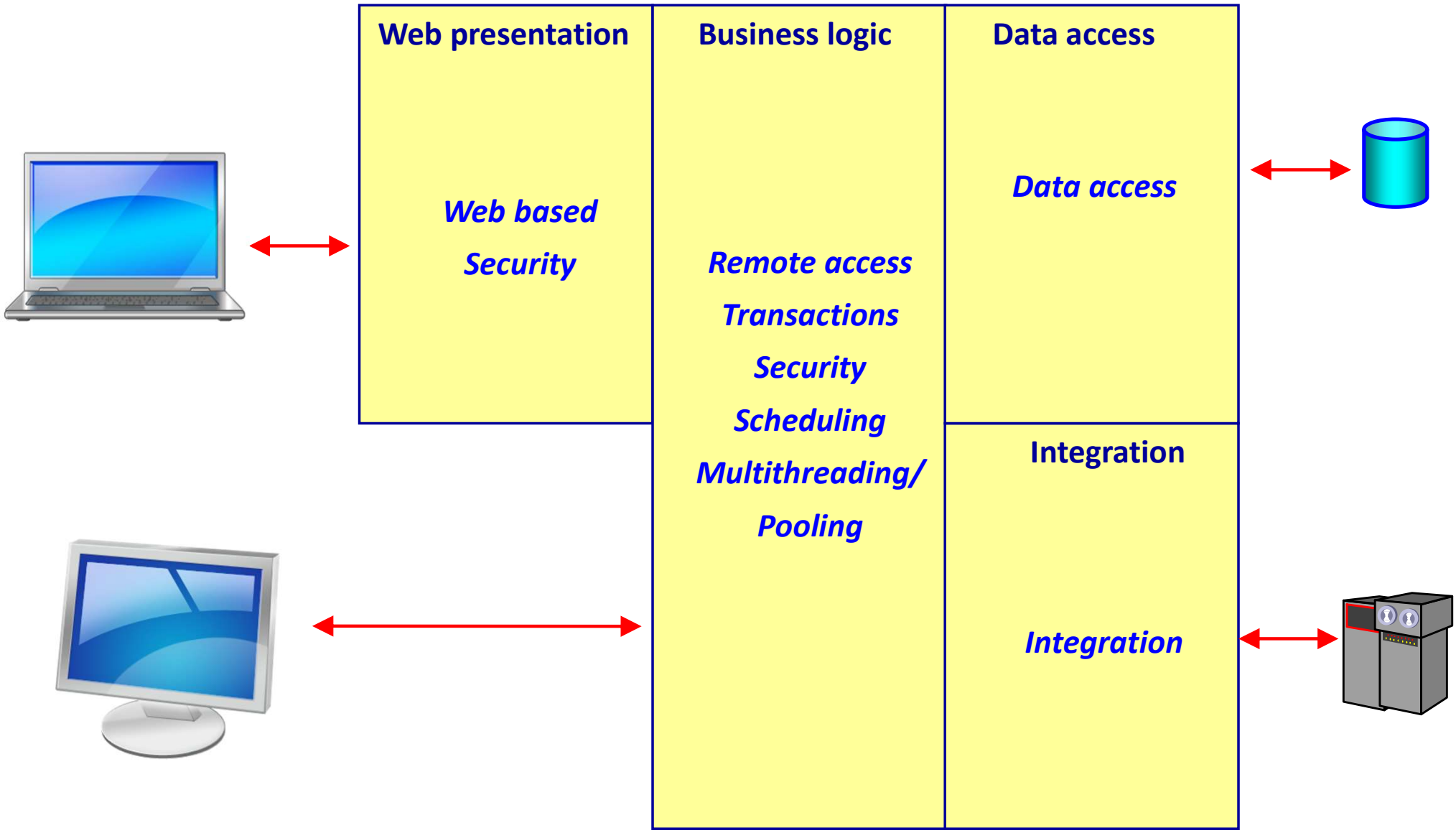
SOA



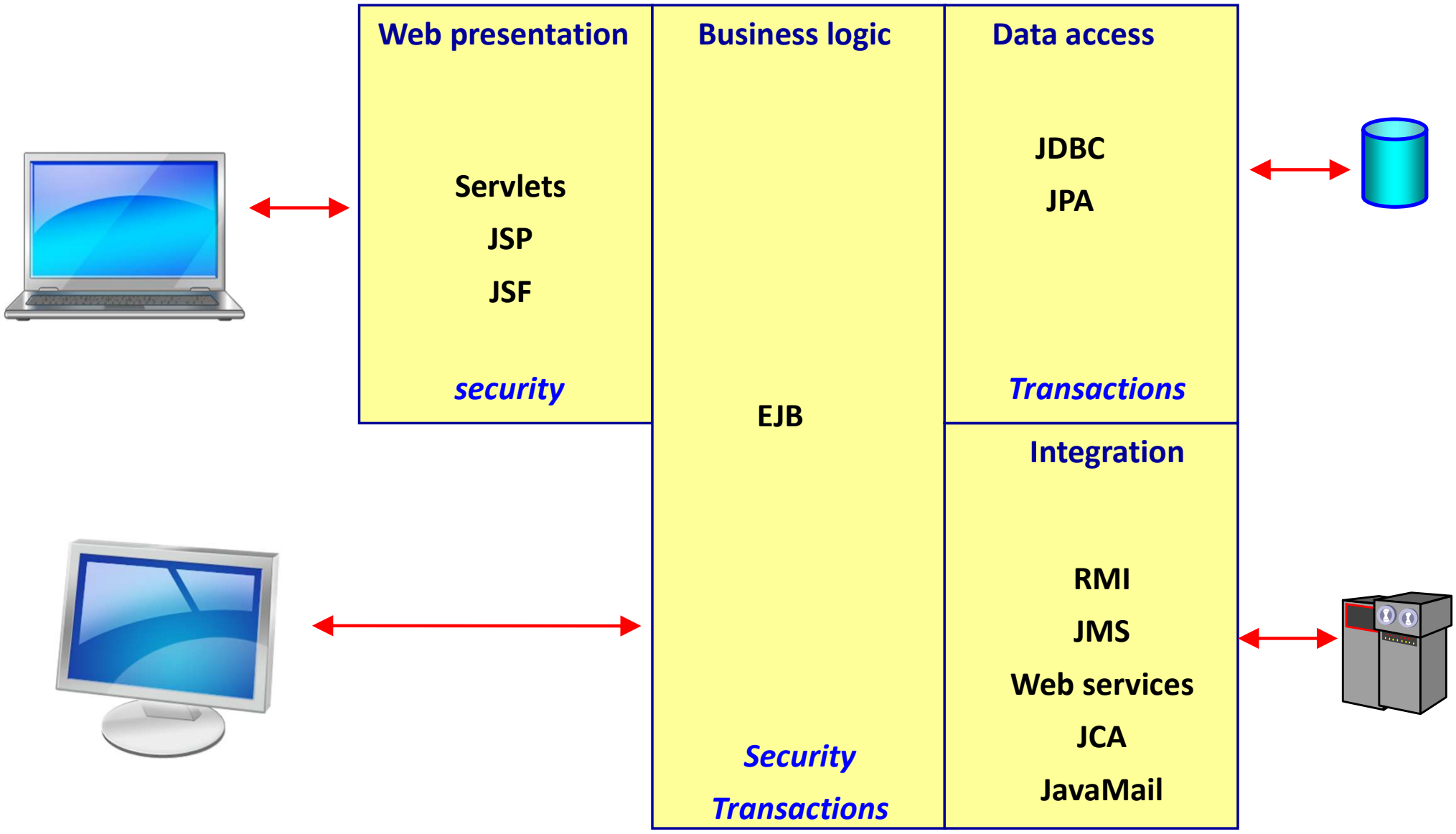
microservices

INTRODUCTION TO SPRING

What is an enterprise application?



Java EE standard



What is Spring?

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

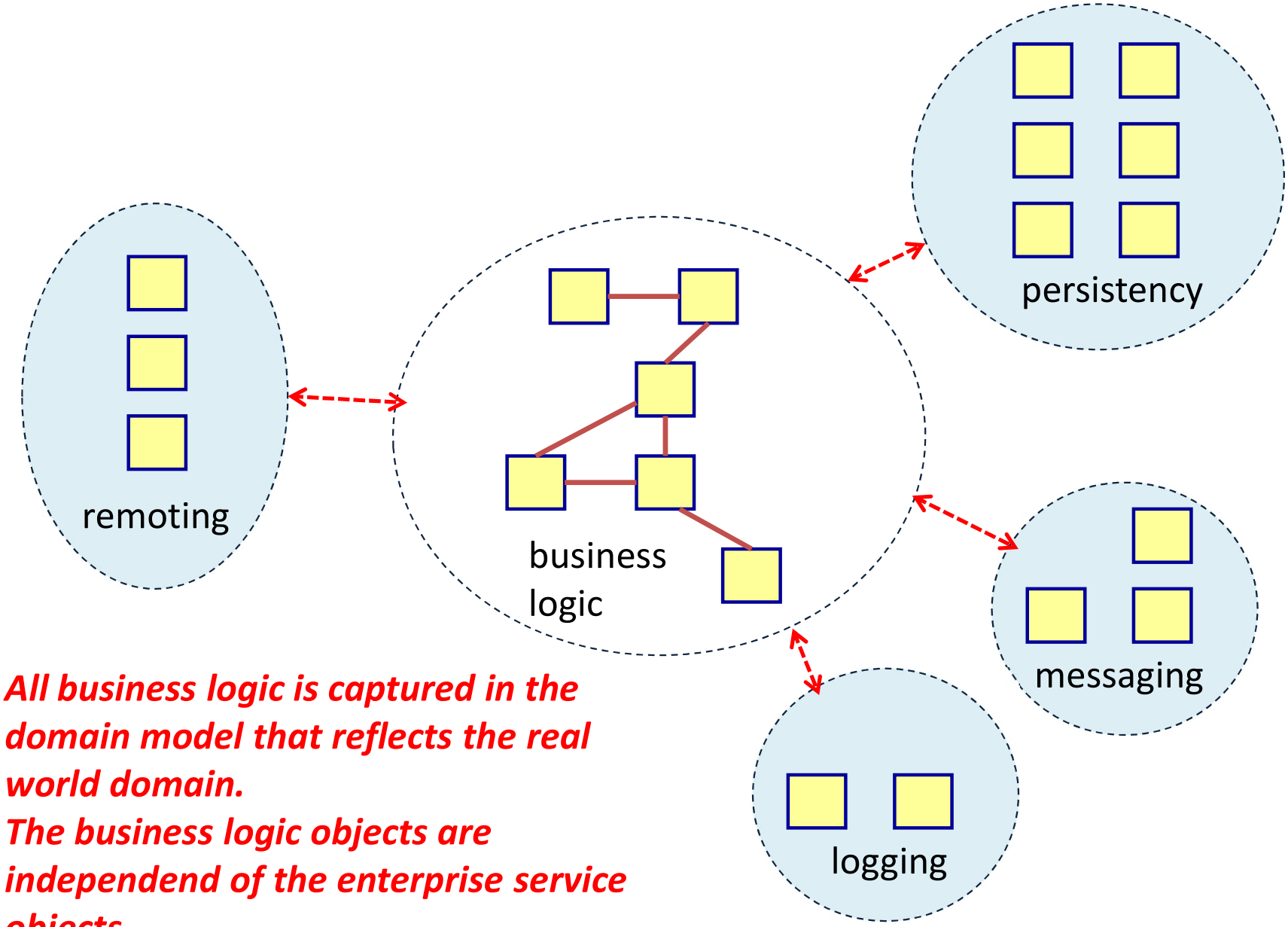
Aim of the Spring framework

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

POJO based programming

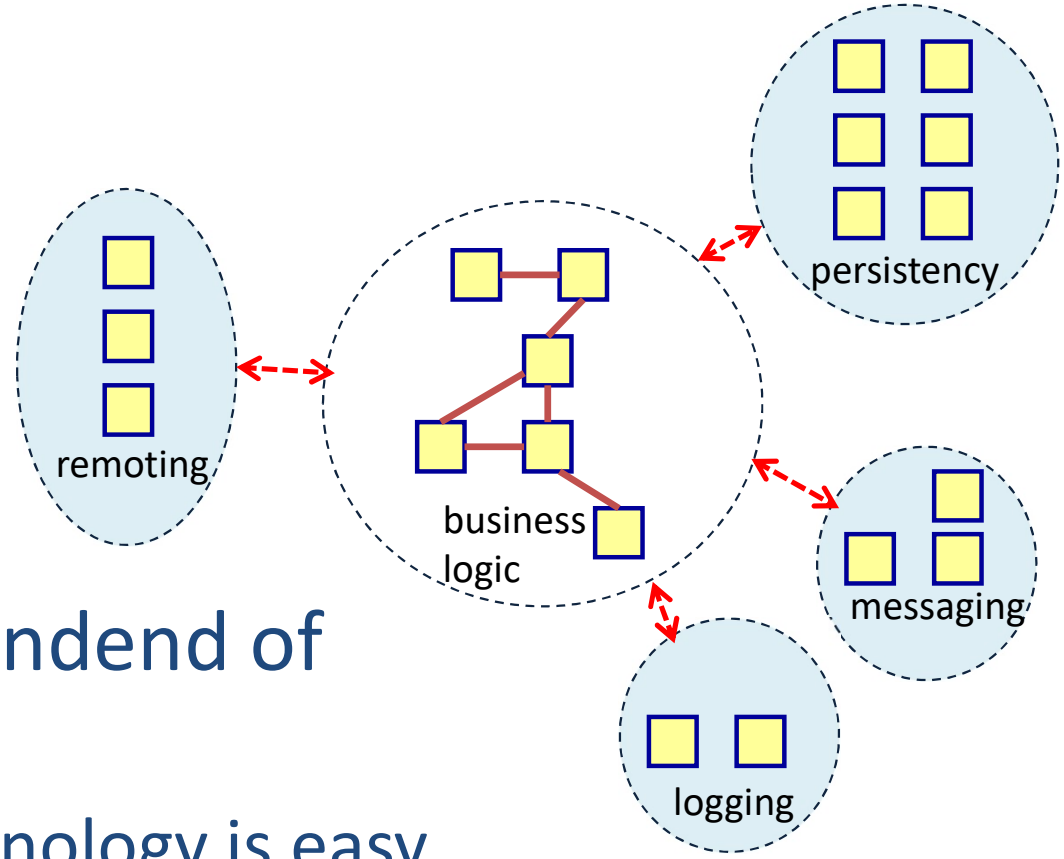
- All code is written in java objects
  - No EJB's
- Promotes Object-Oriented principles
- Simple to understand
- Simple to refactor
- Simple to unit test

Domain-Driven Design (DDD)



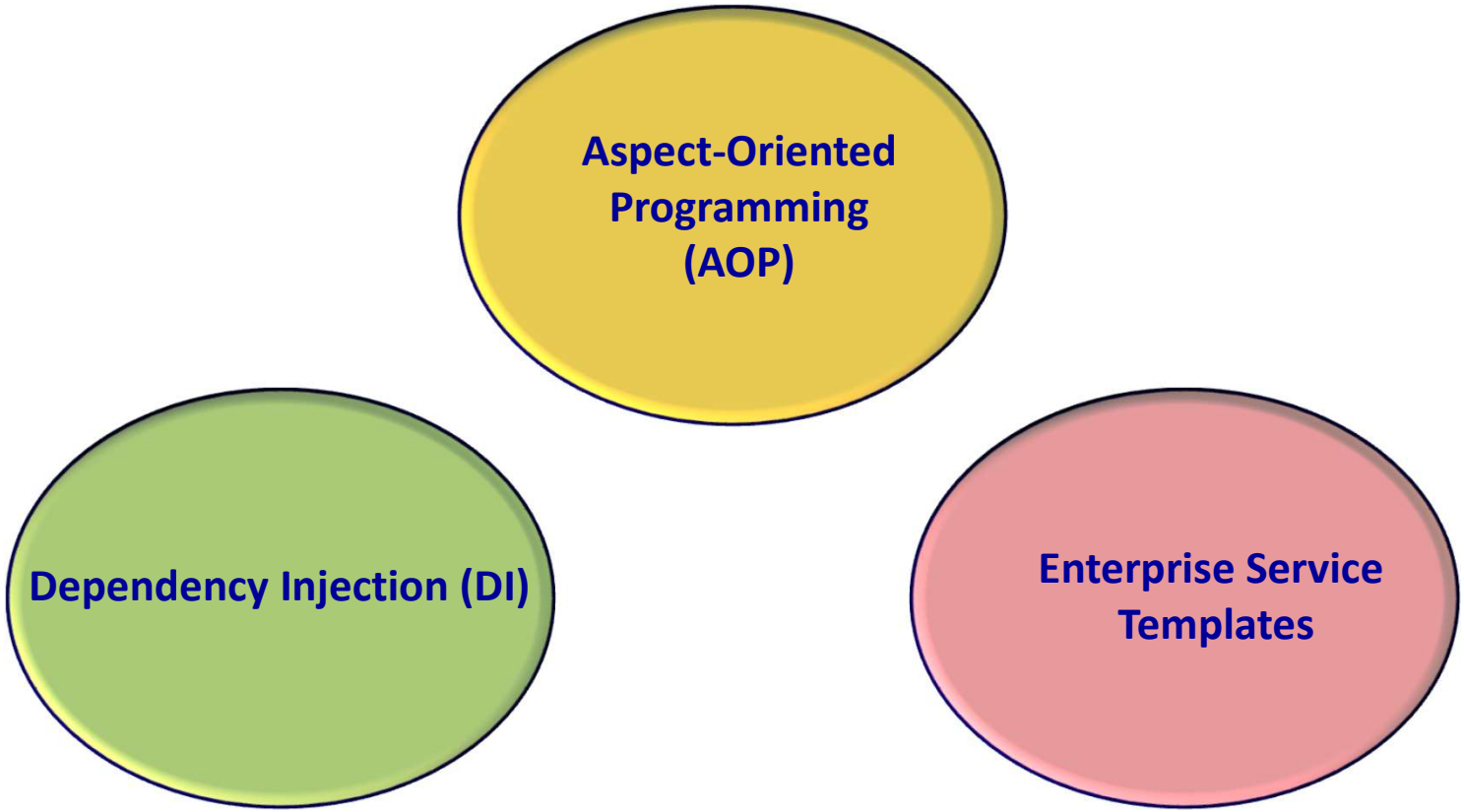
1. ***All business logic is captured in the domain model that reflects the real world domain.***
2. ***The business logic objects are independend of the enterprise service objects***

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

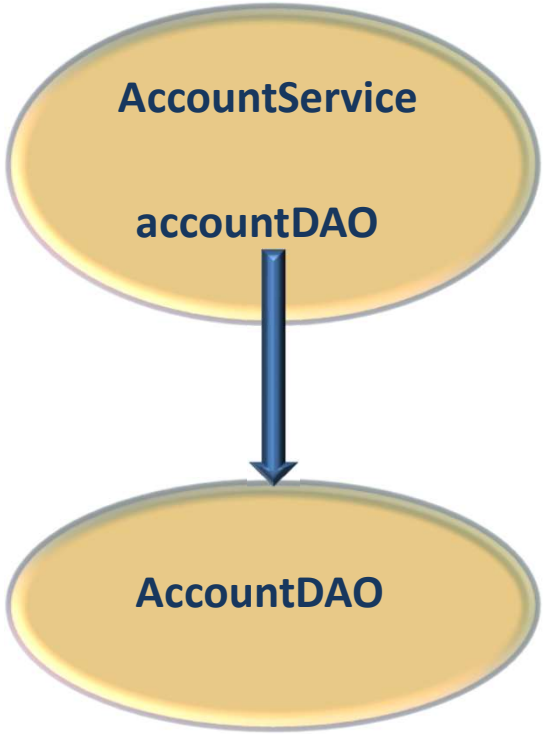
Core of Spring



Dependency Injection

- Spring instantiates objects and wires them together

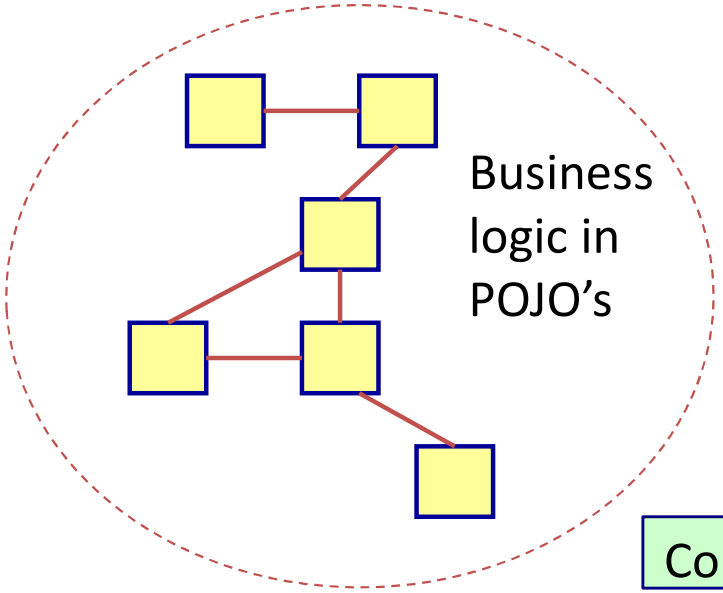
```
public class AccountService {
   private AccountDAO accountDAO;

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

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



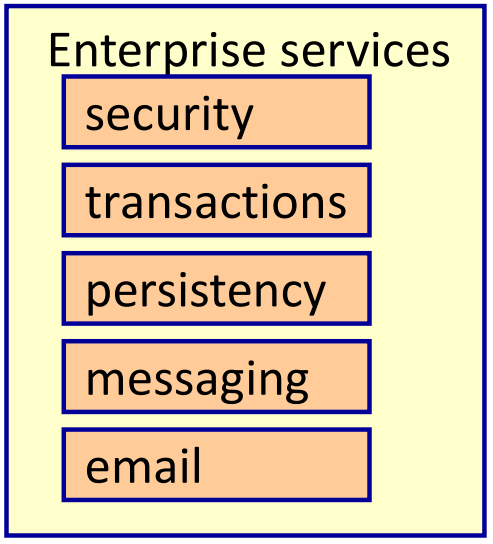

```
<bean id="accountService" class="bank.AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="bank.dao.AccountDAO" />
```

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

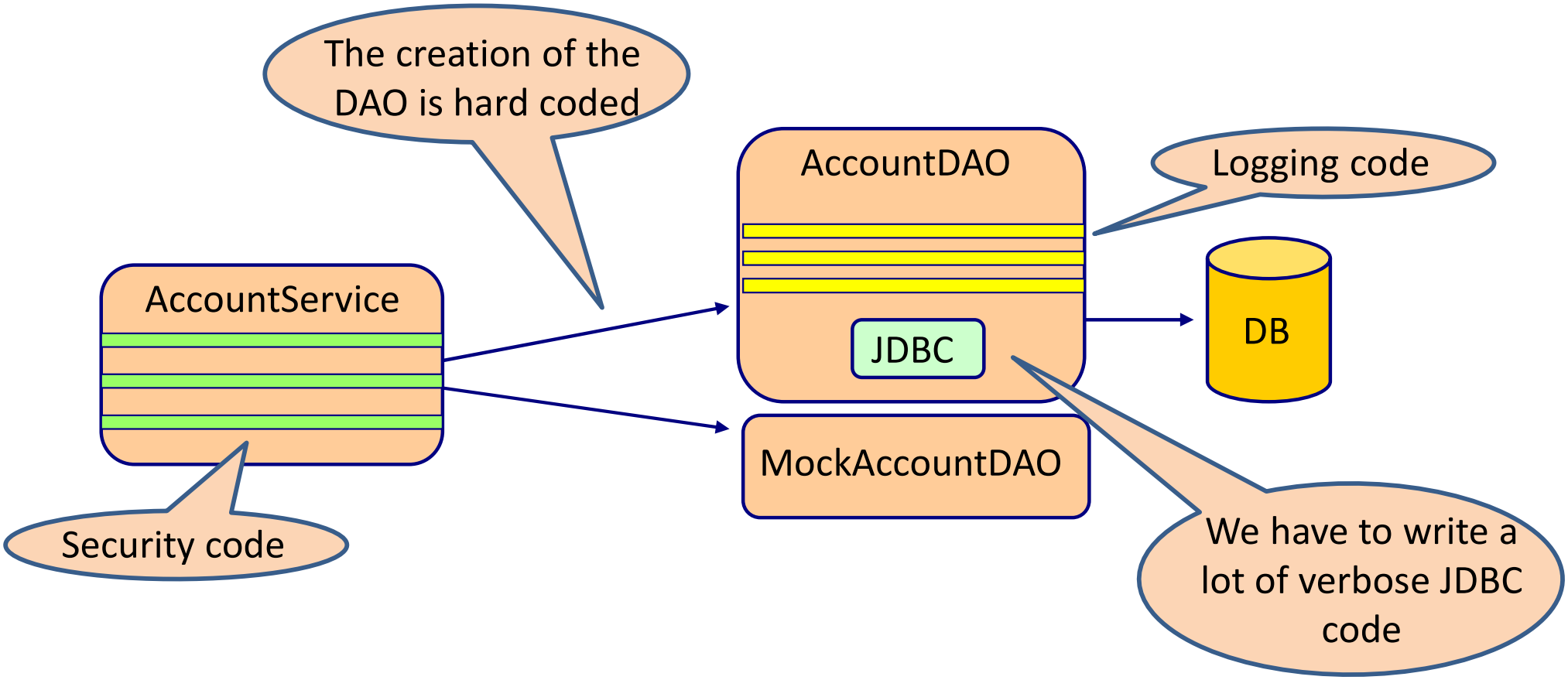


Enterprise Service Templates

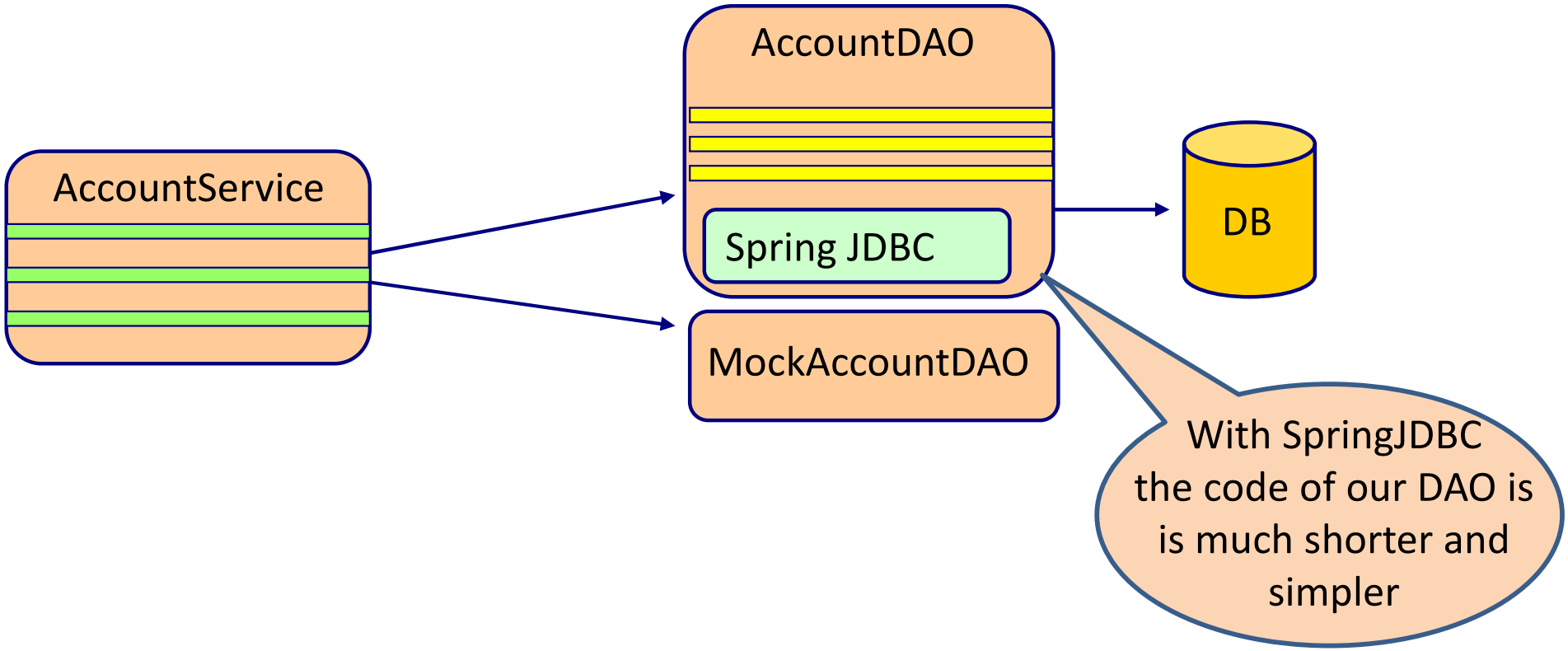
- Makes programming the different enterprise service API's simpler.
  - JDBC template
  - JMS template
  - JavaMail template
  - Hibernate template

- 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

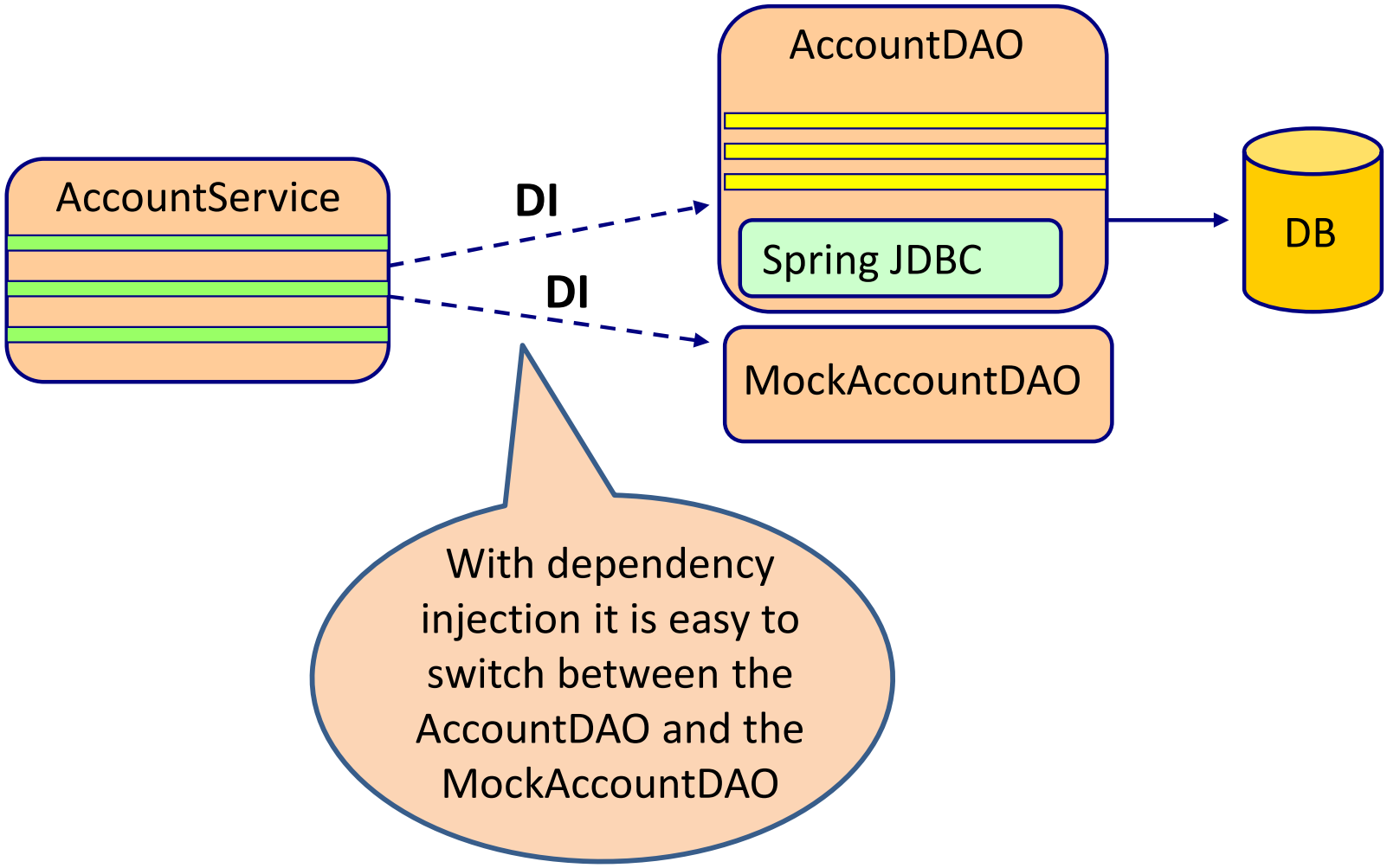
Without Spring



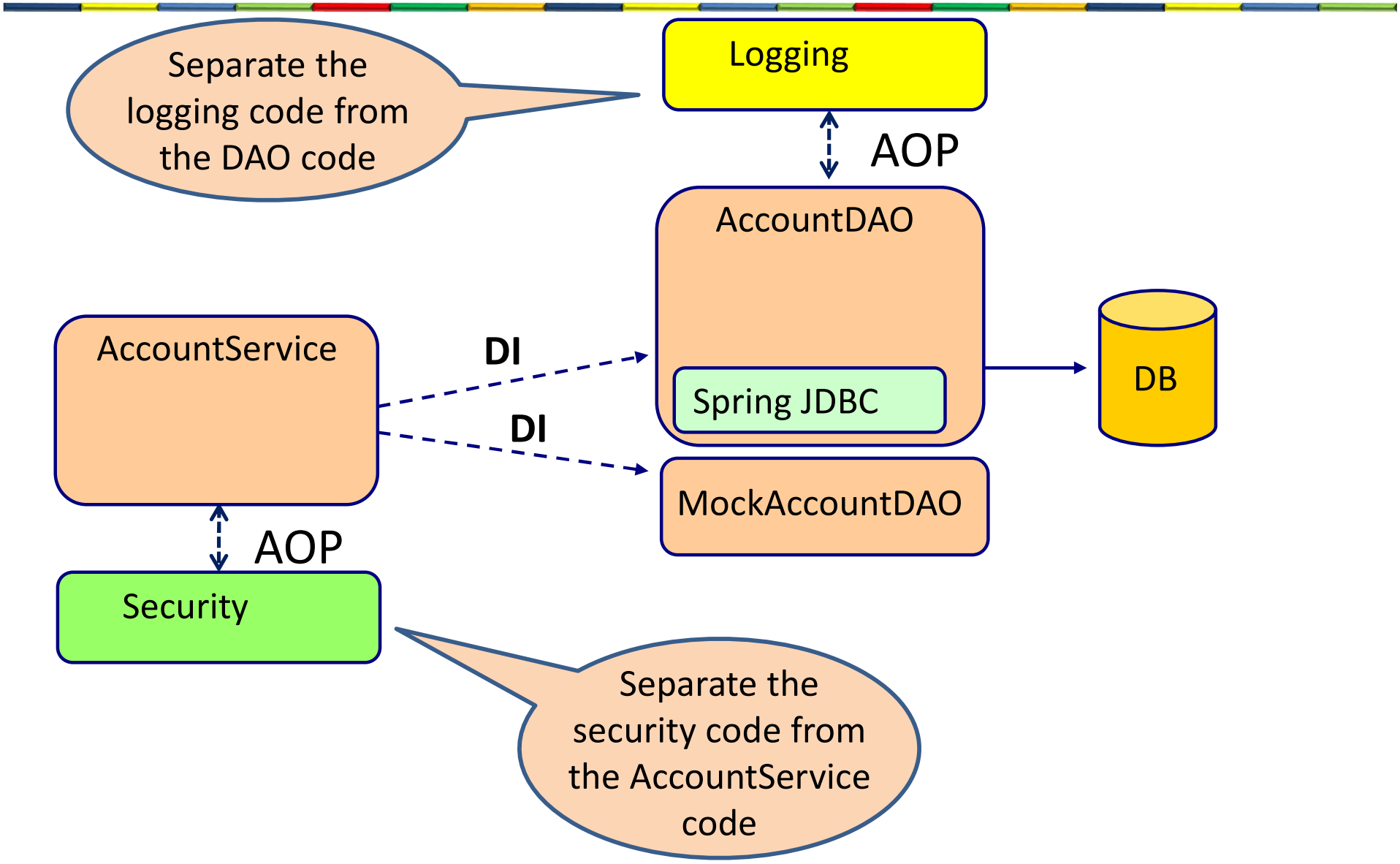
Add SpringJDBC



Add Dependency Injection



Use AOP


Separate the logging code from the DAO code
Logging
AOP
AccountDAO
AccountService
DI
DI
Spring JDBC
DB
MockAccountDAO
AOP
Security
Separate the security code from the AccountService code

Spring ecosystem

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

SPRING BASICS

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

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

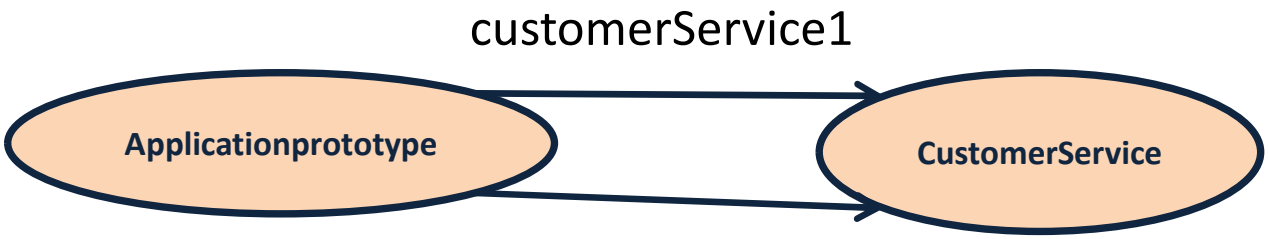
Spring beans are default singletons

```
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
```



Prototype beans

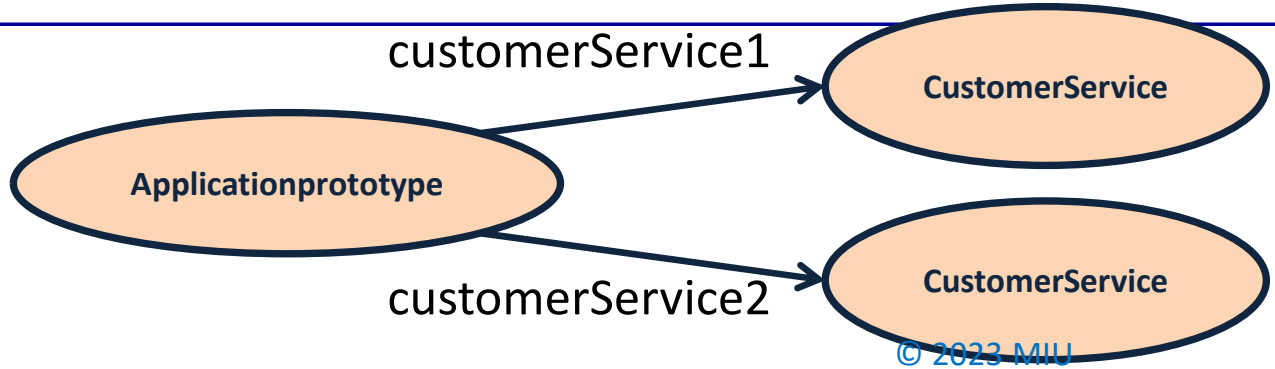
```
public class Application{
  public static void main(String[] args) {
    ApplicationContext context =
                    new ClassPathXmlApplicationContext("module2/prototype/springconfig.xml");
    CustomerService customerService1 = context.getBean("customerService", CustomerService.class);
  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

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

prototype



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

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

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

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

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

Lifecycle methods with annotations

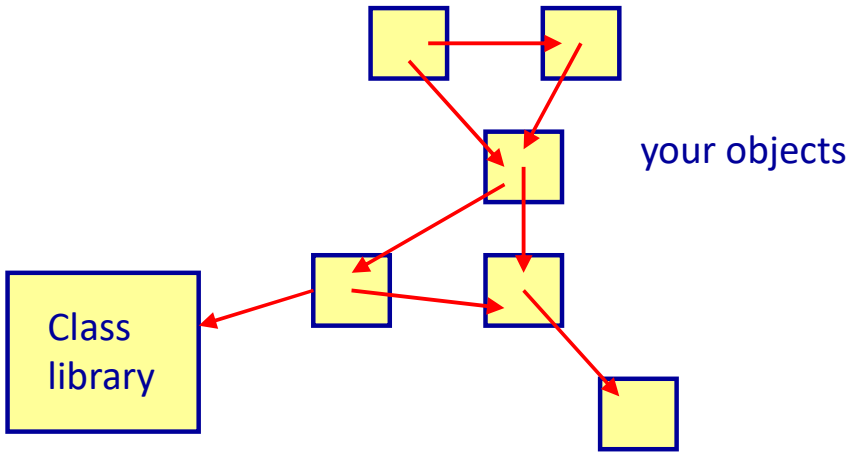
```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation=
          "http://www.springframework.org/schema/beans
           http://www.springframework.org/schema/beans/spring-beans-3.0.xsd"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

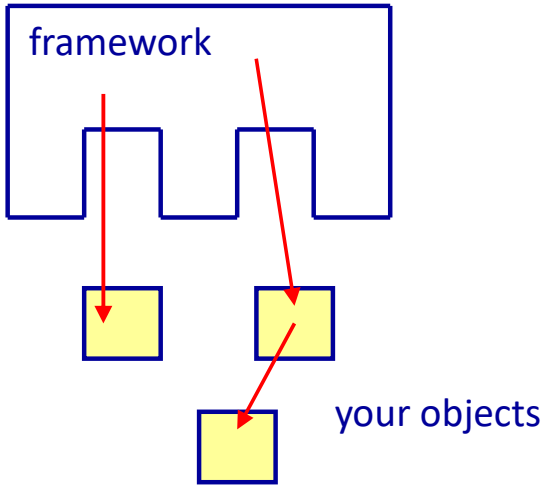
DEPENDENCY INJECTION

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



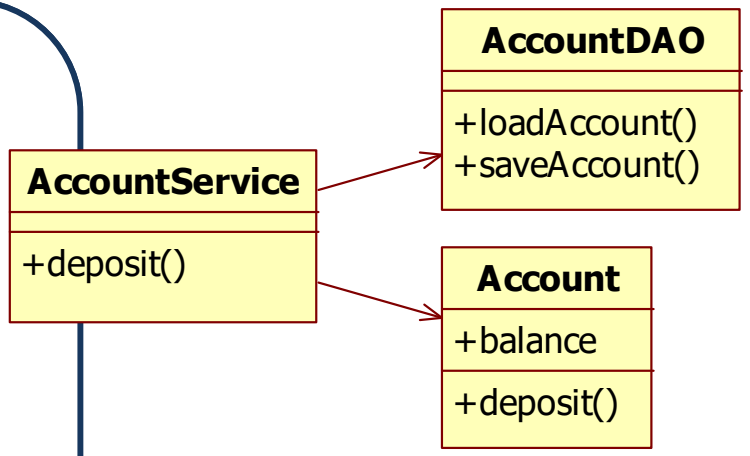
IoC: The framework calls your code

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

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);
  }
}
```

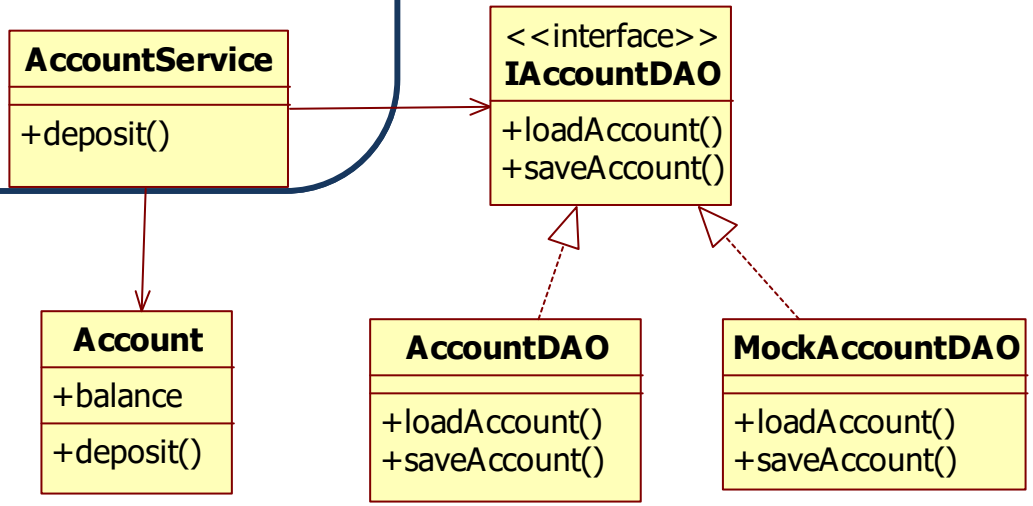


- The relation between AccountService and AccountDAO is hard coded
  - If you want to change the AccountDAO implementation, you have to change the code

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

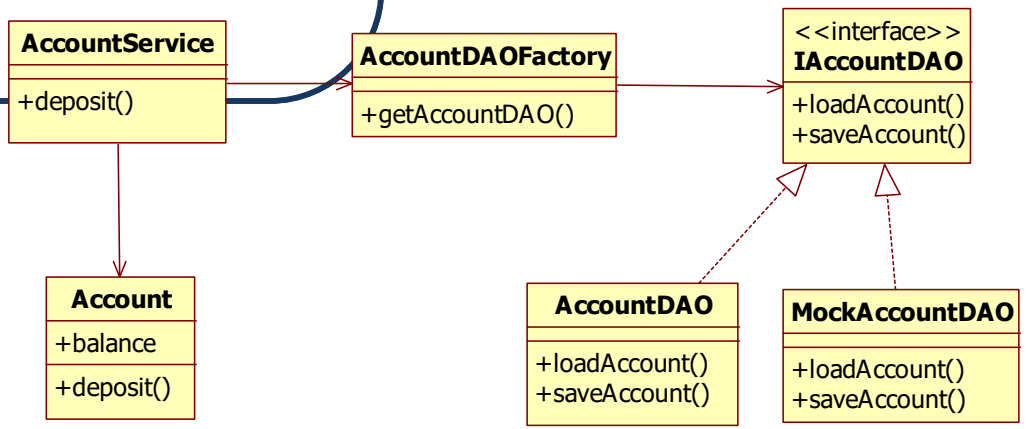


- The relation between AccountService and AccountDAO is still hard-coded
  - We have more flexibility, but if you want to change the AccountDAO implementation to the MockAccountDAO, you have to change the code

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

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

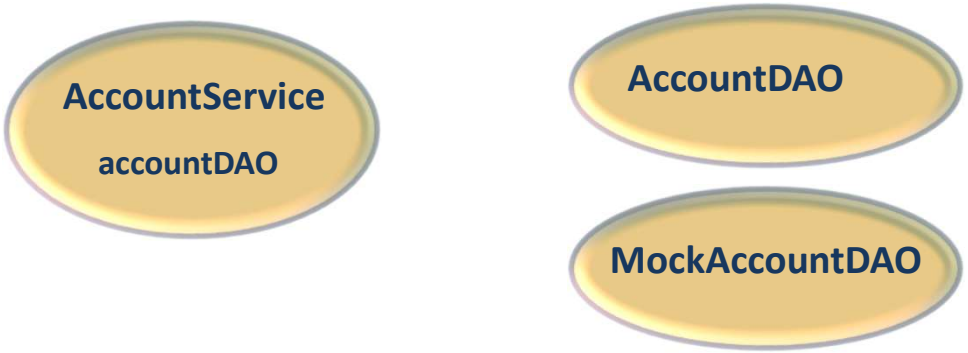
```
<bean id="accountService" class="AccountService">
  <property name="accountDAO" ref="accountDAO" />
</bean>
<bean id="accountDAO" class="AccountDAO" />
<bean id="mockAccountDAO" class="MockAccountDAO" />
```

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

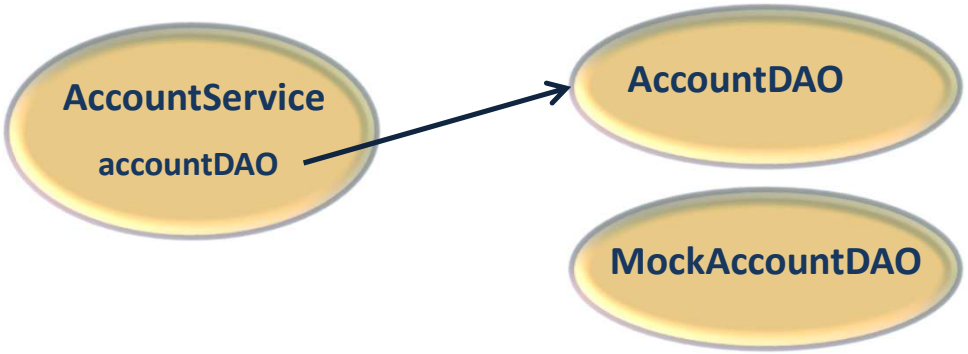
How does DI work?

```
<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



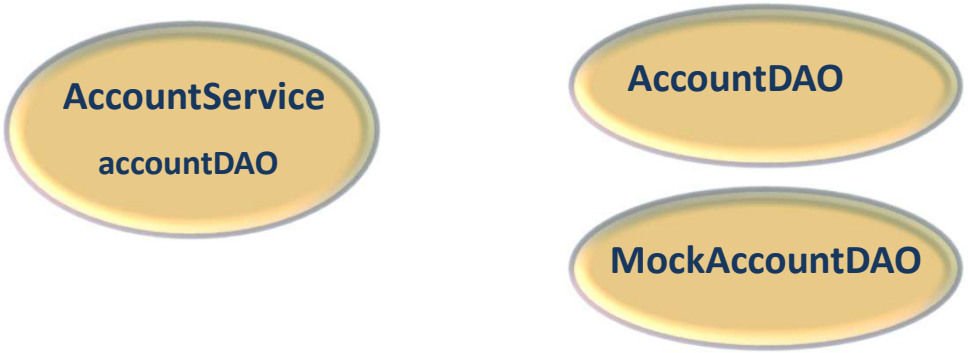
2. Spring then connects the accountDAO attribute to the AccountDAO instance



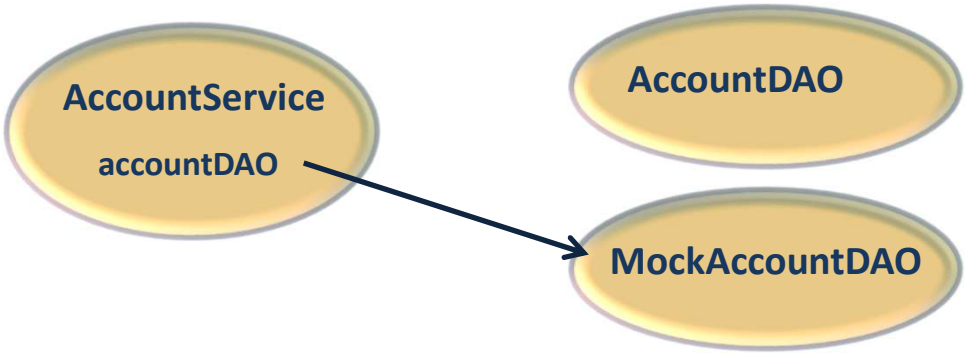
Change the wiring

```
<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



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

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.

DIFFERENT TYPES OF DI

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Types of DI

- Setter injection
- Constructor injection
- Autowiring

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 …/>

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 …/>

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

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

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

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

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

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.

Autowiring

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

Autowiring by name

```
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

```
public class EmailService {

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

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

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

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"/>
```

Constructor autowiring

```
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

```
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"/>
```

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"/>
```

Annotation based Autowiring by type

```java
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

```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"/>
```

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"/>
```

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();
  }
}
```

Autowiring

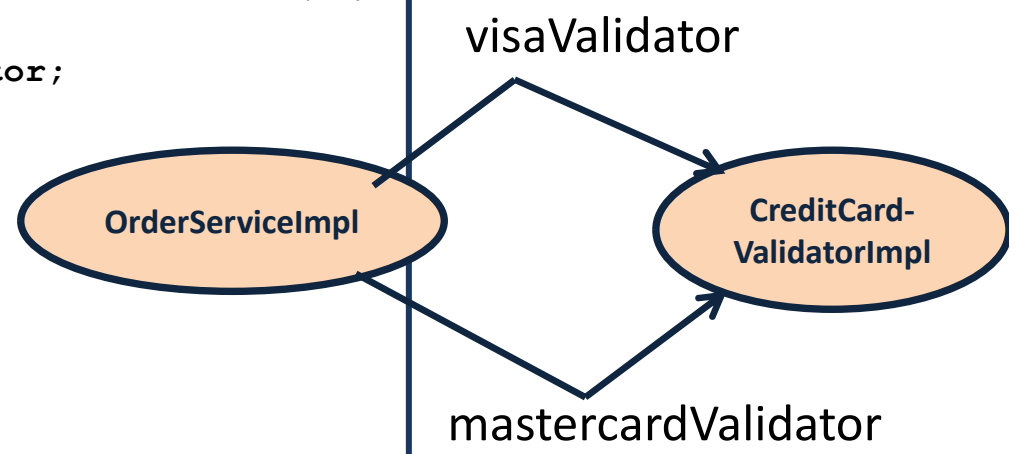
- Advantage
  - Makes configuration of bean wiring simpler
- Disadvantages
  - The Spring XML file does not contain all the explicit details on how the beans are wired together
  - Autowire by type gives the restriction that you can have only 1 bean of the given type

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);
      }
    }
  }
}
```



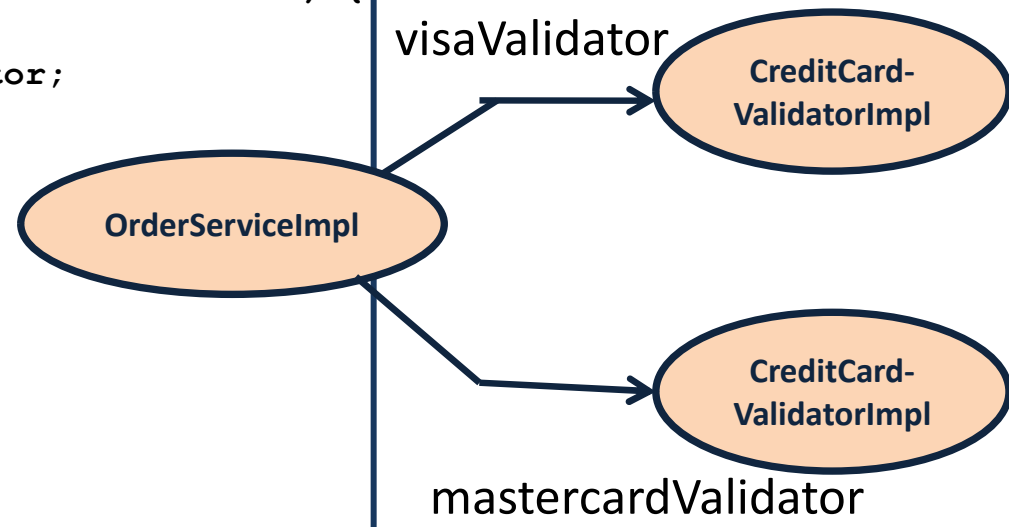

```
<bean id="orderService" class= "OrderServiceImpl">
  <constructor-arg  index="0"  ref="creditcardVerifier" />
  <constructor-arg  index="1"  ref="creditcardVerifier" />
</bean>
<bean id="creditcardVerifier" class="CreditCardValidatorImpl"/>
```

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

Injection of primitive values

```java
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;
  }
}
```

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

Automatic conversion from String to long

DEPENDENCY INJECTION WITH CLASSPATH SCANNING

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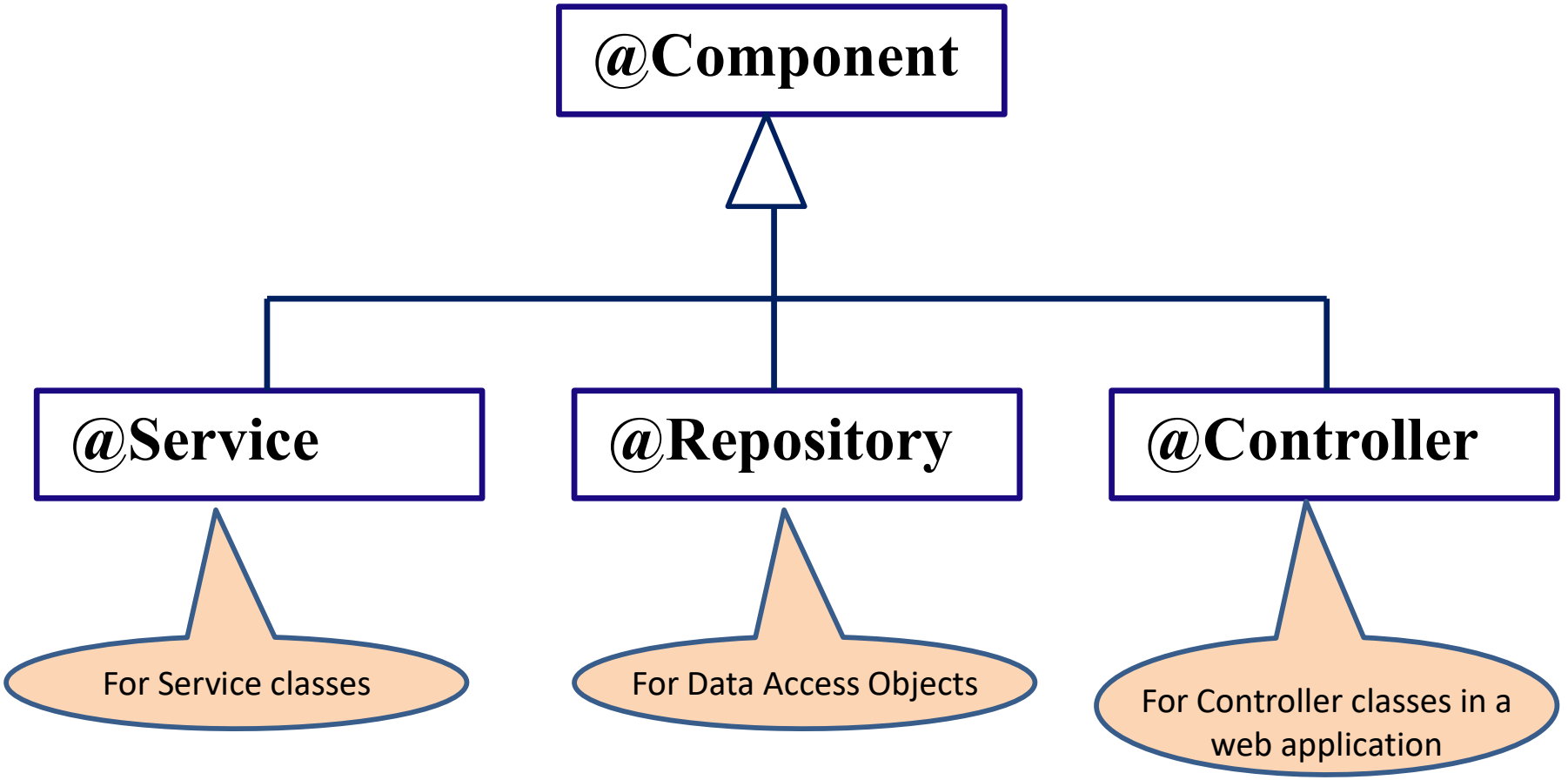
Classpath scanning

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

  become spring beans

Classpath scanning annotations



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

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();
  }
}
```

@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

@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

DEPENDENCY INJECTION WITH JAVA CONFIGURATION

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Java Configuration

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

```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();
  }
}
```

Similar configuration

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

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");
  }
}
```

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();
  }
}
```

@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

@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

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

3 WAYS TO CONFIGURE SPRING APPLICATIONS

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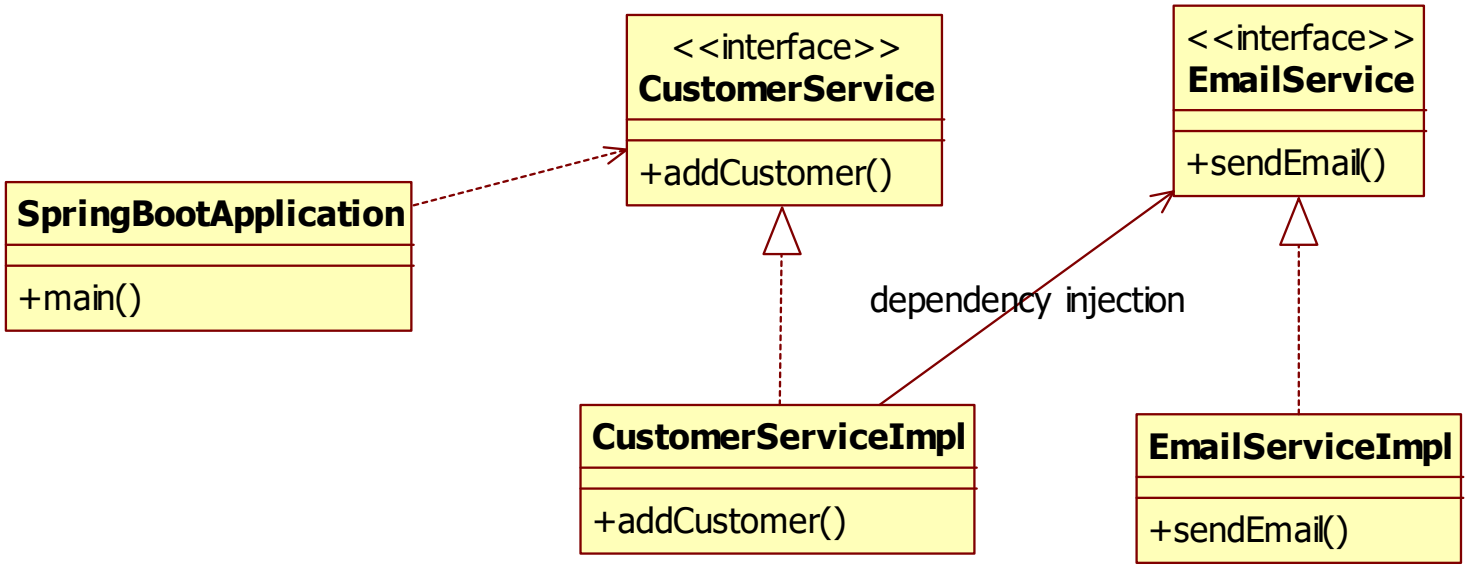
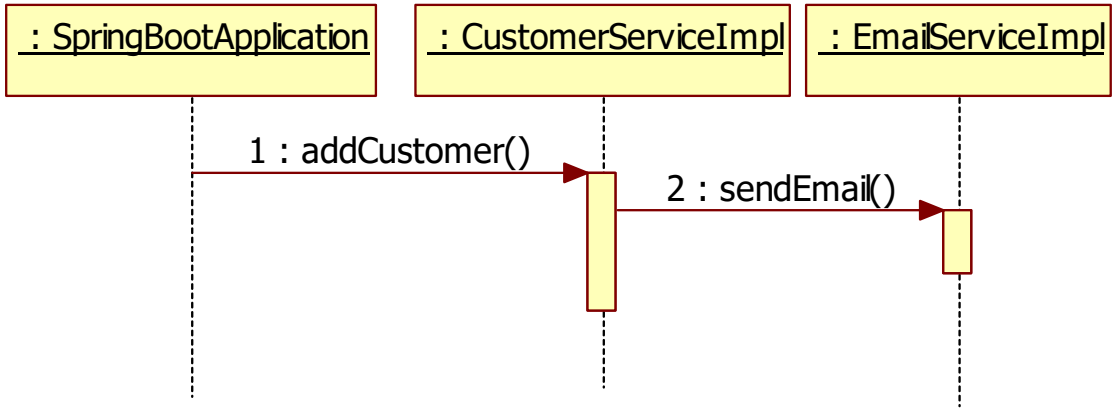
3 ways of Spring configuration

- XML configuration
- Classpath scanning and Autowiring
- Java configuration

Example application





The implementation

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

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

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

```
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

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

Option 1: XML configuration

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

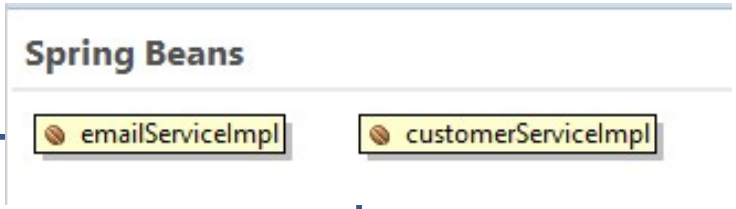

```java
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

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

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

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();
  }
}
```

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

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

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();
  }
}
```

Most simple 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.

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.