Spring

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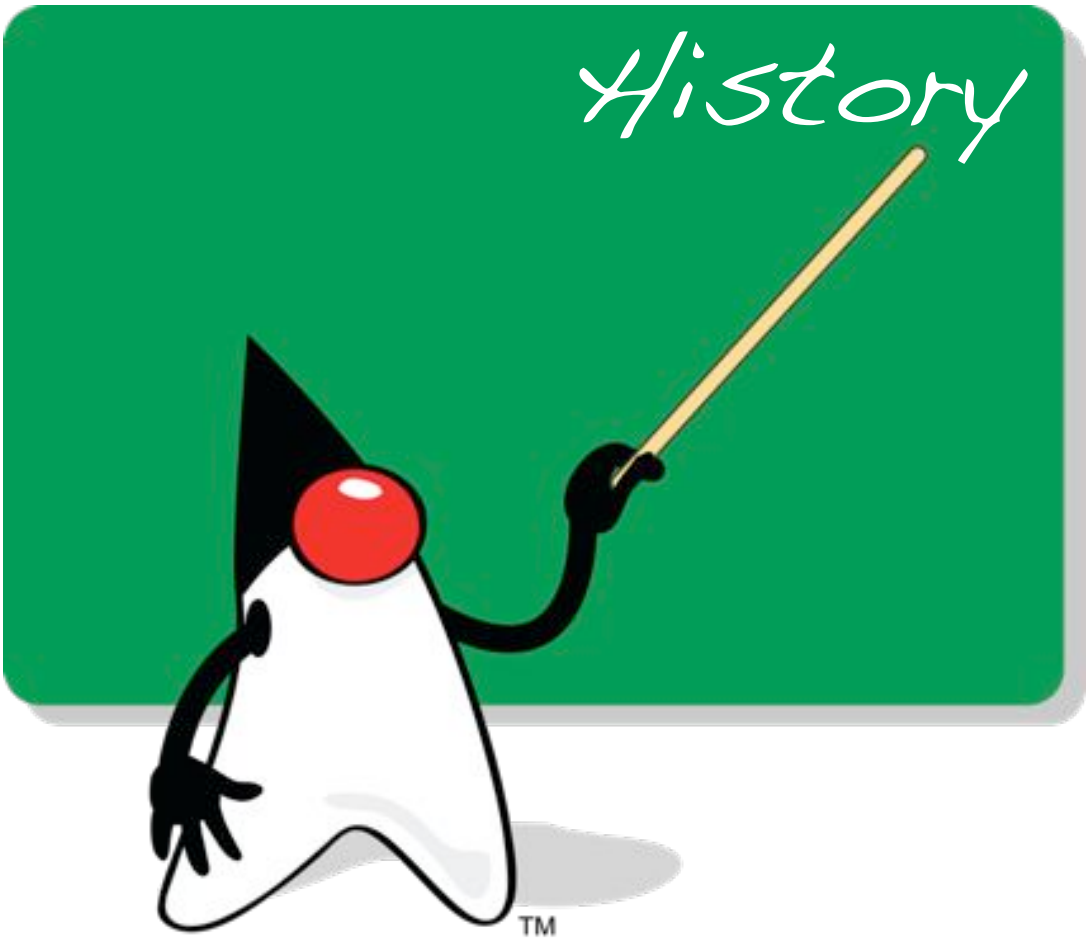
- Spring Annotations
- AOP
- Data Access & Transaction management
- JDBC
- JPA Integration
- Web MVC
- RESTful web services
- Spring Security
- JMS
- Remoting
- SOAP web services
- Tasks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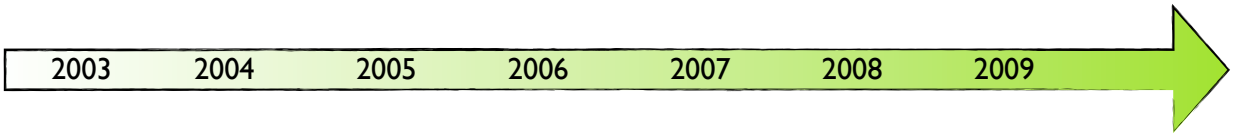
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Founded

Rebranded

2003 2004 2005 2006 2007 2008 2009

Open Source Project created

Funding raised

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2003 2004 2005 2006 2007 2008 2009

Open Source Project created

Funding raised

- Apache technology
  - HTTP Server
  - Tomcat

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Groovy & Grails

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Tomcat monitoring & administration

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Amazon Elastic Cloud integration

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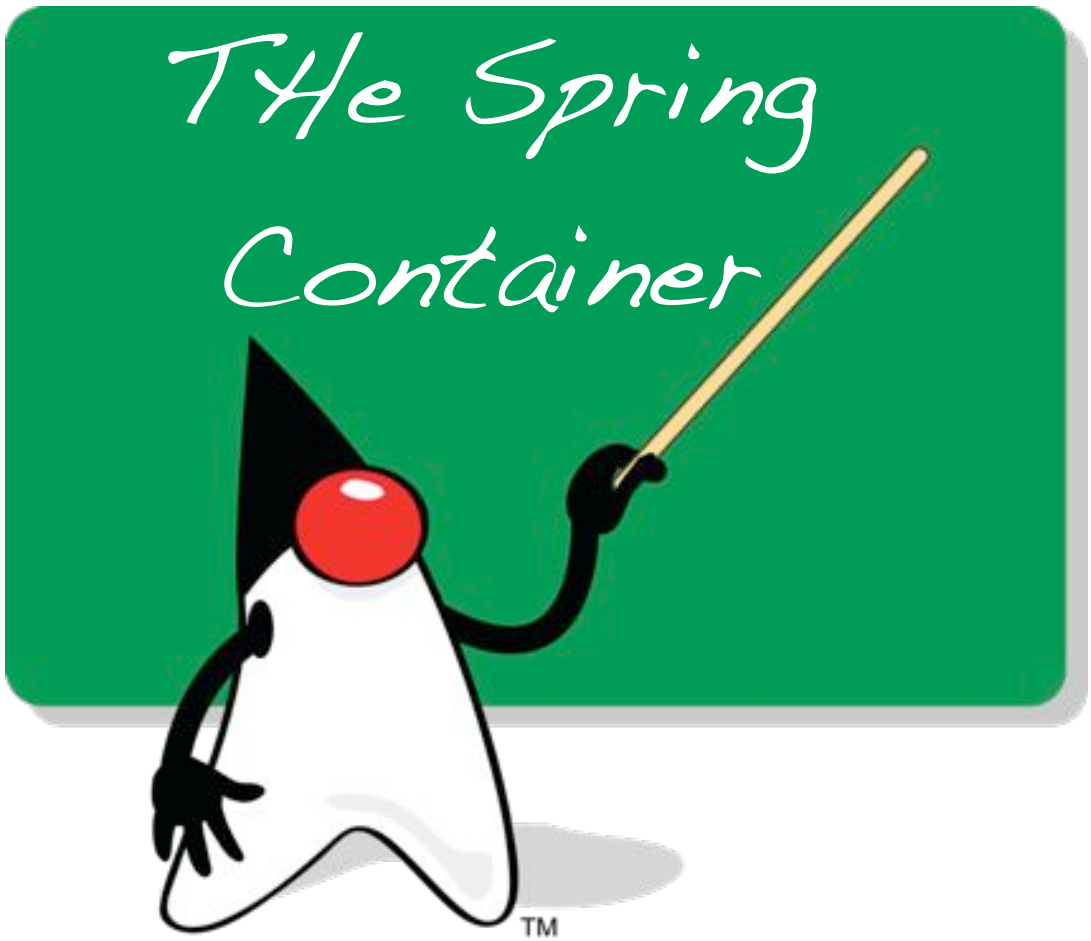
Virtualization of Enterprise Java applications



The ApplicationContext

- Each Spring application has an ApplicationContext
- Defined in a XML file
- Should be on the classpath of the application

```
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:util="http://www.springframework.org/schema/util"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans-3.0.xsd" >
```

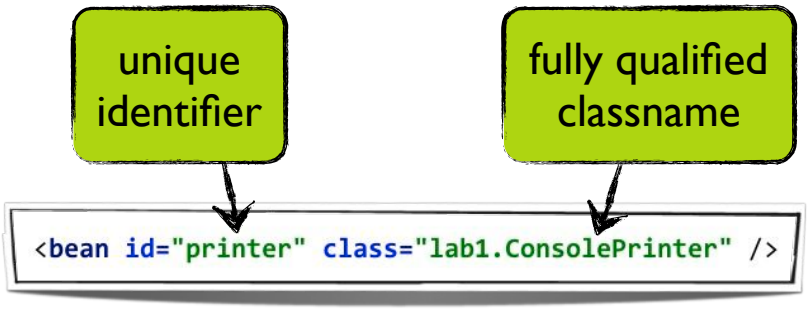

Spring beans

- Any Java class configured in applicationContext.xml
- A Spring Bean is singleton by default

```
<bean id="printer" class="lab1.ConsolePrinter" />
```

Spring beans

- Any Java class configured in applicationContext.xml
- A Spring Bean is singleton by default



Spring bean example

- Plain POJO class
  - optionally implement an interface
- Must have no-arg constructor

```
public class ConsolePrinter implements PrinterService {

    public void print(String message) {
        System.out.println(message);

    }

}
```

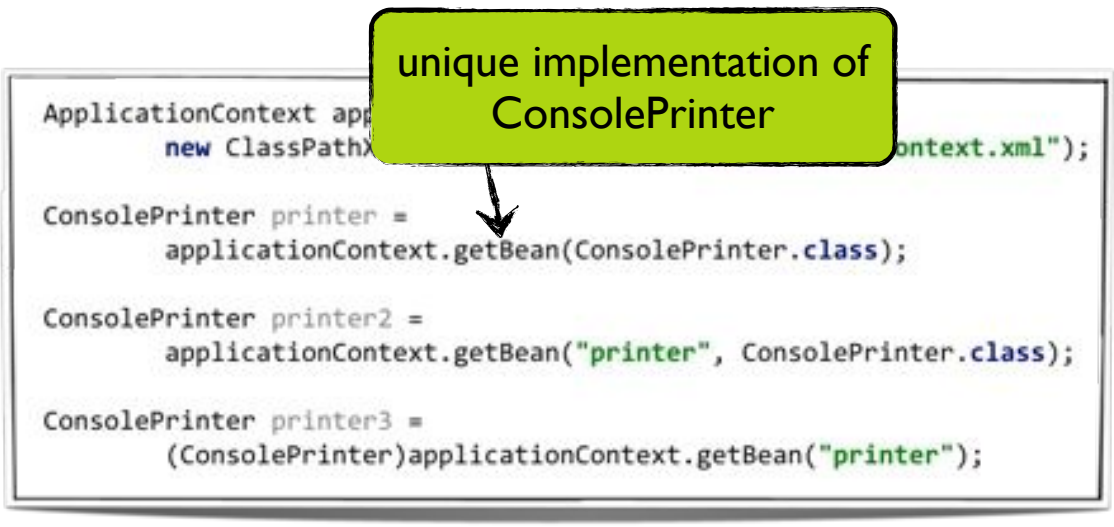
Starting a Spring container

- Just for stand-alone applications

```
ApplicationContext applicationContext =
        new ClassPathXmlApplicationContext("applicationContext.xml");

ConsolePrinter printer =
        applicationContext.getBean(ConsolePrinter.class);

ConsolePrinter printer2 =
        applicationContext.getBean("printer", ConsolePrinter.class);

ConsolePrinter printer3 =
        (ConsolePrinter)applicationContext.getBean("printer");
```


Starting a Spring container

- Just for stand-alone applications



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Starting a Spring container

- Just for stand-alone applications

```
ApplicationContext appl
        new ClassPathX                    ntext.xml");

ConsolePrinter printer
        applicationCont                   ),

ConsolePrinter printer2 =
        applicationContext.getBean("printer", ConsolePrinter.class);

ConsolePrinter printer3 =
        (ConsolePrinter)applicationContext.getBean("printer");
```

Get by ID with type-parameter

Starting a Spring container

- Just for stand-alone applications

```
ApplicationContext applicationContext =
        new ClassPathXmlApplicationContext("applicationContext.xml");

ConsolePrinter printer =
        applicationContext.getBean(Cons

ConsolePrinter printer2 =
        applicationContext.getBean("pri

ConsolePrinter printer3 =
        (ConsolePrinter)applicationContext.getBean("printer");
```

Get by ID (needs type cast)

Dependency Injection

- Only **define** a dependency, don't instantiate or lookup dependencies
- Spring wires dependencies
  - Setter injection
  - Constructor injection
- Dependencies are injected at bean creation time

Constructor Injection

```
public class ConstructorDI {
    private PrinterService printer;

    public ConstructorDI(PrinterService printer) {

        this.printer = printer;
    }
```

```
<bean id="printer" class="lab1.ConsolePrinter" />

<bean id="constructorDI" class="lab1.ConstructorDI">
    <constructor-arg ref="printer"/>
</bean>
```

Constructor Injection

- Arguments are resolved by type
  - argument order cannot be determined

```
public ConstructorDI(PrinterService printer,
                     OtherDependency otherDependency) {
    this.printer = printer;
    this.otherDependency = otherDependency;
}
```

```
<bean id="constructorDI" class="lab1.ConstructorDI">
    <constructor-arg ref="printer"/>
    <constructor-arg ref="otherDependency"/>
</bean>
```


Constructor type ambiguity

```
public ConstructorDI(String myString, int myInt) {
    this.myString = myString;
    this.myInt = myInt;
}
```

```
<bean id="constructorDI" class="lab1.ConstructorDI">
    <constructor-arg type="java.lang.String" value="Hello"/>
    <constructor-arg type="int" value="1"/>
</bean>
```

Remove ambiguity for simple types using explicit types

Constructor type ambiguity

```
public ConstructorDI(String myString, int myInt) {
    this.myString = myString;
    this.myInt = myInt;
}
```

```
<bean id="constructorDI" class="lab1.ConstructorDI">
    <constructor-arg index="0" value="Hello"/>
    <constructor-arg index="1" value="1"/>
</bean>
```

Remove ambiguity for simple types using argument index

Setter Injection

```
public class SetterDI {
    private PrinterService printer;

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

```
<bean id="printer" class="lab1.ConsolePrinter"/>

<bean id="setterDI" class="lab1.SetterDI">
    <property name="printer" ref="printer"/>
</bean>
```

AutoWiring

- Wire dependencies automatically
  - don't specify dependencies using `<property/>` or `<constructor-arg/>`
- Less XML configuration
- Add / remove dependencies more easily
- Turn on globally or per bean

AutoWiring Types

Mode	Explanation
no	No autowiring (default)
byName	Property name must match bean id
byType	Property type must match **exactly one** bean. Must have default constructor.
constructor	Injection by type using a constructor. All arguments must be resolvable.
autodetect (deprecated)	Chooses between *byType* and *constructor*.

AutoWiring byType

```
<bean id="autowiringDI" class="lab1.AutoWireDI" autowire="byType"/>
```

```
public class AutoWireDI {
    private PrinterService printer;

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


Checking dependencies

Mode	Explanation
none	No dependency checking (default)
simple	Only primitive types and collections
object	Only collaborators
all	Primitive types and collaborators

Deprecated in Spring 3

AutoWiring constructor

```
<bean id="autowiringDI" class="lab1.AutoWireDI" autowire="constructor"/>
```

```
public class AutoWireDI {
    private PrinterService printer;

    public AutoWireDI(PrinterService printer) {
        this.printer = printer;
    }
```


AutoWire byName

```
<bean id="printer" class="lab1.ConsolePrinter"/>

<bean id="autowiringDI" class="lab1.AutoWireDI" autowire="byName"/>
```

```
public class AutoWireDI {
    private PrinterService printer;

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

AutoWire byName

```
<bean id="printer" class="lab1.ConsolePrinter"/>

<bean id="autowiringDI" class="lab1.AutoWireDI" autowire="byName"/>
```

must match

```
public class AutoWireDI {
    private PrinterService printer;

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


Global AutoWiring

```
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:util="http://www.springframework.org/schema/util"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd"
       default-autowire="byType">
```

Autowire-candidate

- When multiple implementations of an interface exists Spring can't autowire
  - choose the implementation to inject

Don't use for injection

```
<bean id="otherDependency" class="lab1.OtherDependency"
      autowire-candidate="false"/>
```

Always use for injection

```
<bean id="otherDependency" class="lab1.OtherDependency"
      primary="true"/>
```


Factory method

- Construct beans using a static factory method

```
public class FactoryMethodInstantiation {
    private FactoryMethodInstantiation() {
    }

    public static FactoryMethodInstantiation createInstance() {
        return new FactoryMethodInstantiation();
    }
```

```
<bean id="factoryMethodInstantiation"
      class="lab1.FactoryMethodInstantiation"
      factory-method="createInstance">
</bean>
```

Factory method arguments

```
<bean id="factoryMethodInstantiation"
      class="lab1.FactoryMethodInstantiation"
      factory-method="createInstance">
    <constructor-arg ref="printer"/>
    <constructor-arg value="MyTest"/>
</bean>
```

```
public class FactoryMethodInstantiation {
    private PrinterService printer;
    private String value;

    private FactoryMethodInstantiation() {
    }

    public static FactoryMethodInstantiation createInstance(
            PrinterService printer, String value) {
        FactoryMethodInstantiation instance =
                new FactoryMethodInstantiation();
        instance.printer = printer;
        instance.value = value;
        return instance;
    }
```


Factory Bean

- Construct and initialize beans that you don't control

```
<bean id="nameFactory" class="lab1.NameFactory"/>

<bean id="names" factory-bean="nameFactory"
      factory-method="createNameList"/>
```

```
public class NameFactory {
    public List<String> createNameList() {
        return Arrays.asList("Paul", "Bert", "Joris");
    }
}
```

Method injection

- Normally injection is done at bean creation time
- Method injection allows injection at each call to a bean
- Spring injects an abstract method implementation

Method injection

```
public abstract class NormalSpringBean {
    public int doSomething() {
        return getDynamicDependency().doSomething();
    }

    public abstract MyDynamicDependency getDynamicDependency();
}
```

```
<bean id="methodInjectionExample" class="lab1.NormalSpringBean">
    <lookup-method name="getDynamicDependency" bean="dynamicBean"/>
</bean>
```

Generates a method that re-inject dynamicBean

Scopes

Scope	Explanation
singleton (default)	A single instance of a the bean. Dependencies to the bean are shared.
prototype	New instance for each injection point. Each injection point creates instance once however.
prototype + method injection	New instance for each call to the injected method.
request (web only)	Instance per HTTP request
session (web only)	Instance per HTTP session

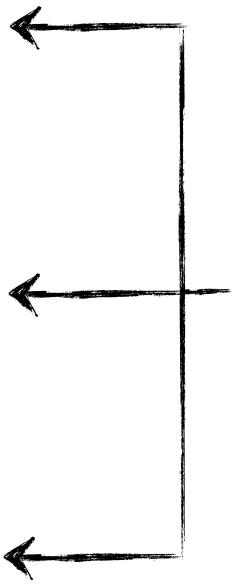
```
<bean id="hitCounter" class="lab1.HitCounter"
      scope="prototype"/>
```


Singleton scope

```
<bean id="hitter1"
      class="lab1.Hitter">
    <property
            name="counter"
            ref="hitCounter"/>
</bean>
```

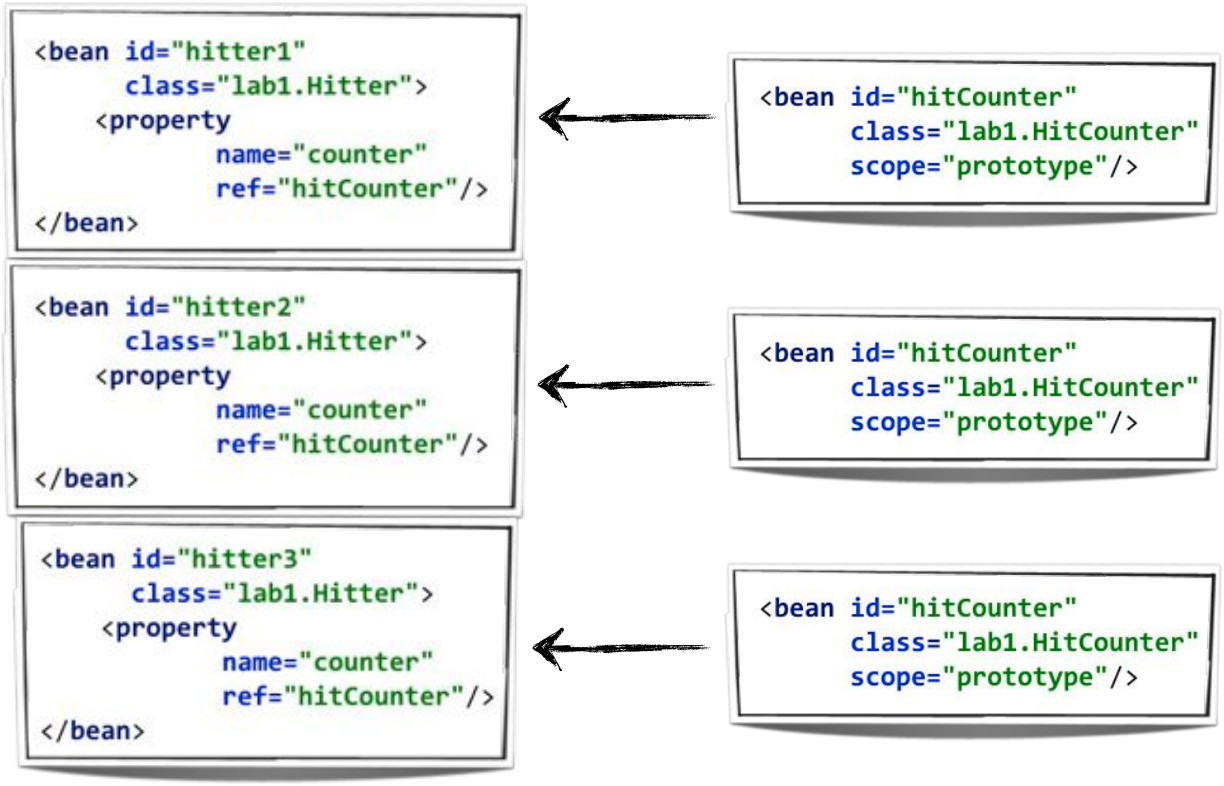
```
<bean id="hitter2"
      class="lab1.Hitter">
    <property
            name="counter"
            ref="hitCounter"/>
</bean>
```

```
<bean id="hitter3"
      class="lab1.Hitter">
    <property
            name="counter"
            ref="hitCounter"/>
</bean>
```



```
<bean id="hitCounter"
      class="lab1.HitCounter"
      scope="singleton"/>
```

Prototype scope



Life-cycle callbacks

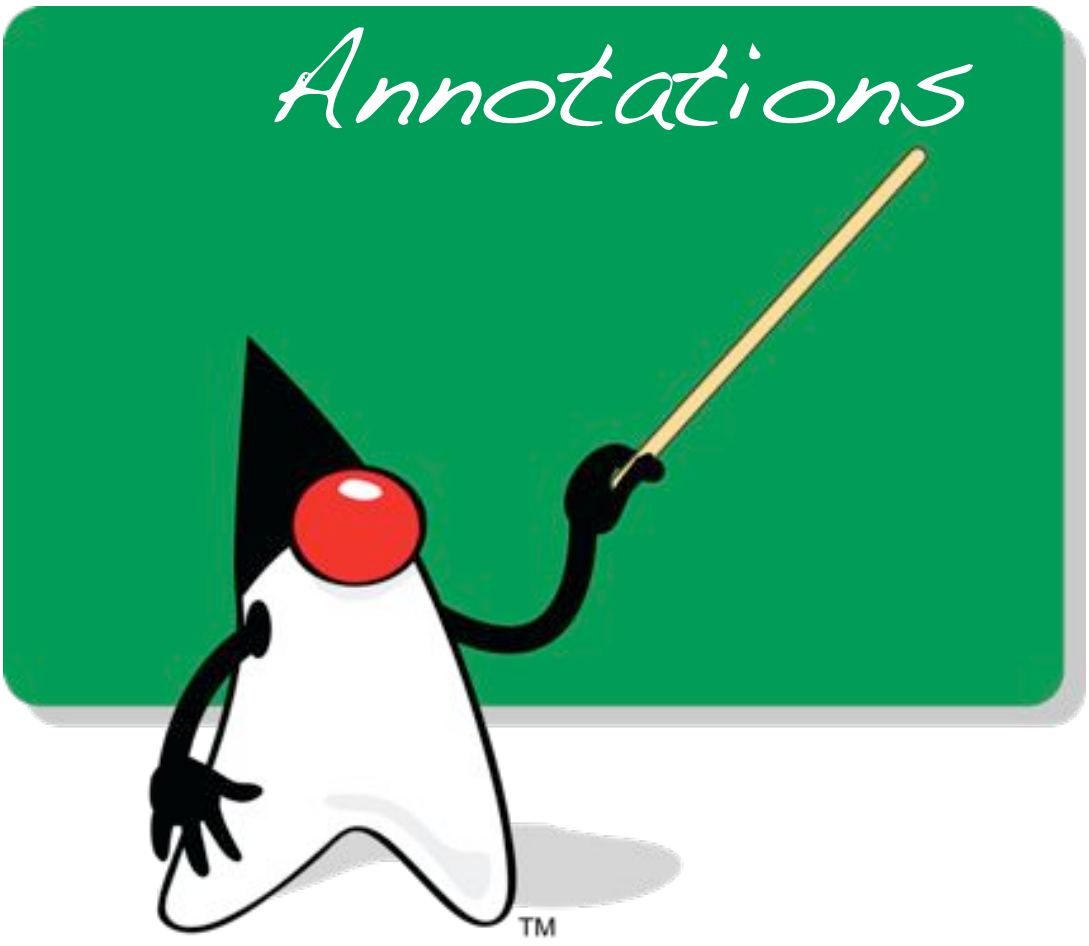
```
public class LifecycleCallbacks {
    public void init() {
        System.out.println("Creating bean");
    }

    public void destroy() {
        System.out.println("Destroying bean");
    }
}
```

```
<bean id="lifecycleCallbacks" class="lab1.LifecycleCallbacks"
      init-method="init" destroy-method="destroy"/>
```

Bean definition inheritance

No instance will be created, just acts as a template

```
<bean id="parentBean" abstract="true" class="lab1.ParentBean">
    <property name="name" value="parent"/>
    <property name="age" value="1"/>
</bean>

<bean id="inheritsWithDifferentName" parent="parentBean">
    <property name="name" value="override"/>
</bean>
```

Configuring annotations

```
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:context="http://www.springframework.org/schema/context"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
    http://www.springframework.org/schema/context
    http://www.springframework.org/schema/context/spring-context-3.0.xsd">

    <context:annotation-config />

    <context:component-scan base-package="lab2"/>
</beans>
```

Turns on annotation based dependency injection

Turns on scanning for @Component etc.

Defining Spring beans

```
@Component
public class SpringComponent {
```

<->

```
<bean id="springComponent"
      class="lab2.SpringComponent"/>
```

```
@Repository
public class SpringDao {
```

```
@Service
public class SpringService {
```

```
@Controller
public class SpringController {
```

Extensions of @Component

@Autowired

Field injection

```
@Autowired
private BookCatalog bookCatalog;
```

Setter injection

```
@Autowired
public void setBookCatalog(BookCatalog bookCatalog) {
    this.bookCatalog = bookCatalog;
}
```

Constructor injection

```
@Autowired
public BookController(BookCatalog bookCatalog) {
    this.bookCatalog = bookCatalog;
}
```


@Inject

- Same semantics as @Autowired
- Standardized in JSR-330
- Needs JSR-330 on the classpath

```
@Inject
private BookCatalog bookCatalog;
```

```
<dependency>
    <groupId>javax.inject</groupId>
    <artifactId>javax.inject</artifactId>
    <version>1</version>
</dependency>
```

@Required

- Works together with XML-based autowired setter injection
- Makes sure a dependency is injected

```
@Required
public void setBookCatalog(BookCatalog bookCatalog) {
    this.bookCatalog = bookCatalog;
}
```


Qualifiers

- Qualifiers bind an injection point to a specific implementation of an interface
  - runtime binding, not compile time
  - unit testing still possible
- Necessary when multiple implementations exist

String based qualifiers

```
@Component
@Qualifier("general")
public class GeneralMovieCatalog implements MovieCatalog {
```

```
@Autowired @Qualifier("general")
private MovieCatalog generalMovies;
```


Qualifier annotations

```
@Component
@Action
public class ActionMovieCatalog implements MovieCatalog{
```

```
@Autowired @Action
private MovieCatalog movieCatalog;
```

```
@Target({ElementType.TYPE,
         ElementType.FIELD,
         ElementType.PARAMETER})
@Retention(RetentionPolicy.RUNTIME)
@Qualifier
public @interface Action {
}
```

custom qualifier annotation

Injecting multiple implementations

All MovieCatalog implementations

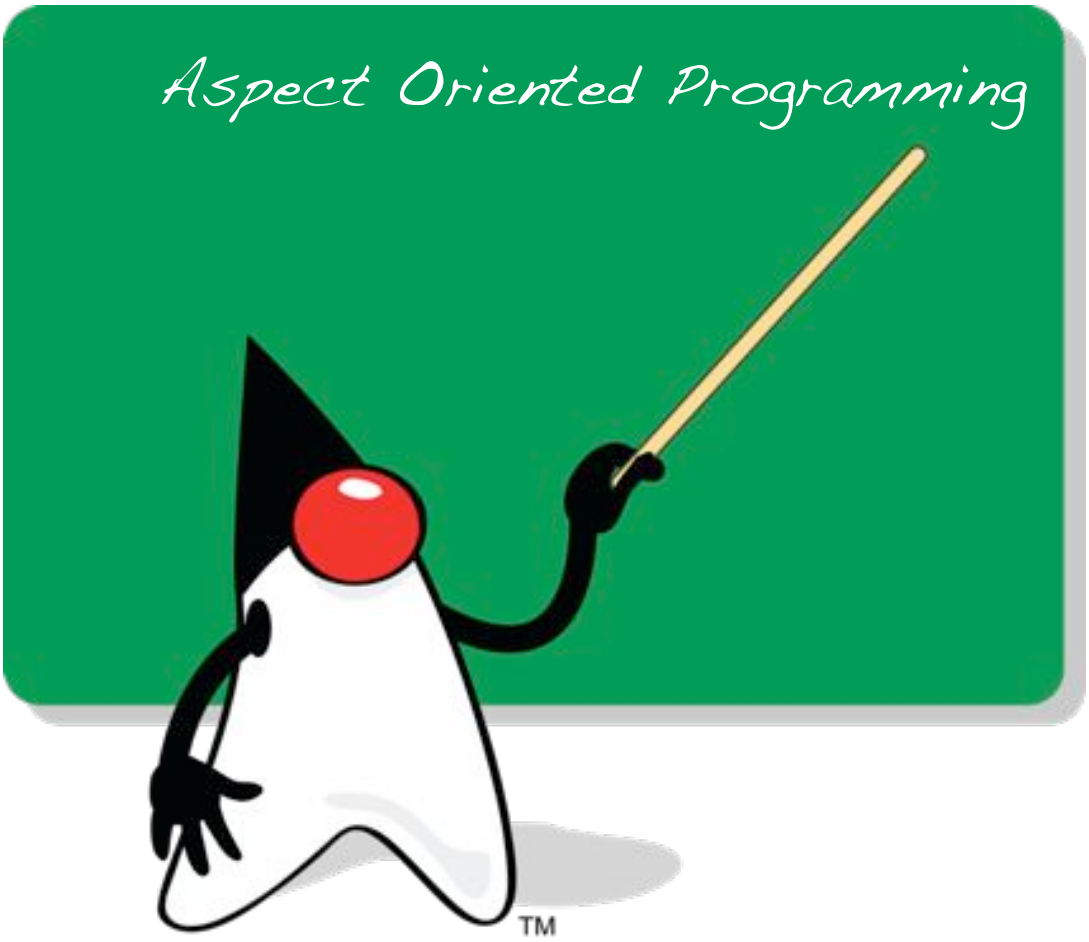
```
@Autowired
List<MovieCatalog> allCatalogs;
```

All MovieCatalog implementations with bean id

```
@Autowired
Map<String, MovieCatalog> allCatalogs;
```


Life-cycle callbacks

```
@PostConstruct
public void init() {

}

@PreDestroy
public void destroy() {

}
```



AOP

- Some *concerns* in an application are *crosscutting*
  - the same code would be repeated at many places
  - e.g. security, logging, retry-on-error etc.
- AOP complements the Object Oriented paradigm

AOP in Java

- AspectJ is the most used AOP implementation
- Needs an additional *weaving* compiler after the Java compiler
  - the build process becomes more complicated
- Spring AOP is easier but less powerful

AOP definitions

- Join point
  - a point during execution of code (a method execution)
- Advice
  - Action taken at a join point
  - e.g. "around", "before" or "after"
  - this is where you implement your code
- Pointcut
  - predicate that matches join points
  - e.g. "all methods in a certain package"

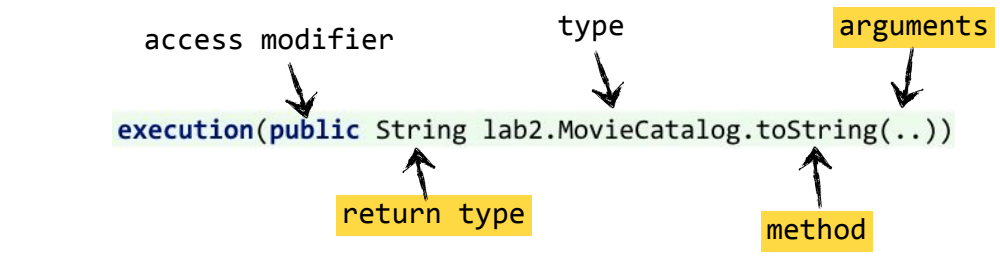
Declaring Aspects

Combined pointcut and advice definition

```
@Aspect
@Component
public class TraceLogAspect {

    @Before("execution(public * *(..))")
    public void before() {
        System.out.println("Called before each public method!");
    }
```

```
<context:component-scan base-package="lab2"/>
<aop:aspectj-autoproxy/>
```


Pointcut definitions



Pointcut examples

Pointcut	Explanation
execution(public * *(..))	All public methods
execution(String *(..))	All methods returning a String
execution(public * save(..))	All public save methods
execution(public * a.b.dao.* (..))	All public methods in the dao package
execution(public String *(String, Integer))	All public methods returning a String and arguments of type String and Integer
@annotation(a.b.MyAnnotation)	All methods annotated a.b.MyAnnotation

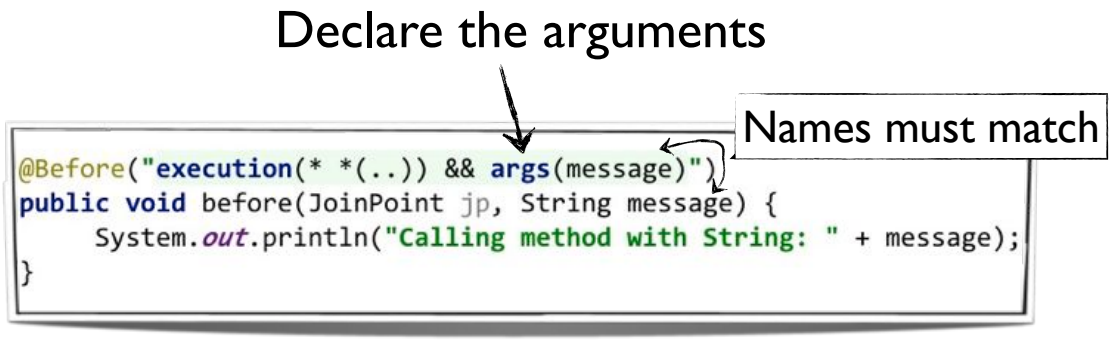
Before advice

```
@Before("execution(* *(..)) ")
public void before() {
}
```

Declare a `org.aspectj.lang.ProceedingJoinPoint` as first parameter

```
@Before("execution(* *(..))")
public void before(JoinPoint jp) {
     System.out.println("Before " + jp.getStaticPart().toString());
}
```

Passing arguments



After advices

```
@AfterReturning(value = "execution(* * (..))", returning = "retVal")
public void afterSuccess(Object retVal) {
    System.out.println("I returned successfully: "
            + retVal);
}

@AfterThrowing(value = "execution(* * (..))", throwing = "ex")
public void afterException(Exception ex) {
    System.out.println("I executed with an exception: "
            + ex.getMessage());
}

@After("execution(* *(..))")
public void after() {
    System.out.println("I'm done!");
}
```

Around advice

Must call *proceed* to continue method call

```
@Around("execution(public * *(..))")
public Object trace(ProceedingJoinPoint jp) throws Throwable {
    long curTime = System.currentTimeMillis();

    Object result = jp.proceed();

    long time = System.currentTimeMillis() - curTime;
    System.out.println(jp.getStaticPart().
                              getSignature().
                              getName() + " " + time);

    return result;
}
```


Retry example

```
@Around("execution(public * *(..))")
public Object retry(ProceedingJoinPoint jp) throws Throwable {
    Object result = null;

    try {
        result = jp.proceed();
    } catch (Exception ex) {
        System.out.println("Sleep 2 seconds before retry");
        TimeUnit.SECONDS.sleep(2);
        result = jp.proceed();
    }

    return result;
}
```

Re-usable pointcut definitions

```java
@Aspect
@Component
public class MyPointcuts {
    @Pointcut("execution(* a.b.dao(..))")
    public void inDaoLayer() {}
}
```

Pointcut name is method name

```java
@After("lab2.aop.MyPointcuts.inDaoLayer()")
public void after() {
    System.out.println("I'm done!");
}
```


AOP using XML

```xml
<aop:config>
    <aop:pointcut expression="execution(* *(..))" id="allMethods"/>
    <aop:aspect ref="traceLogAspect">
        <aop:before method="trace" pointcut-ref="allMethods"/>
    </aop:aspect>
</aop:config>
```

Introductions

- Introduce new methods and interfaces to a class
- How to make a car fly and shoot?
  - mix-in behavior

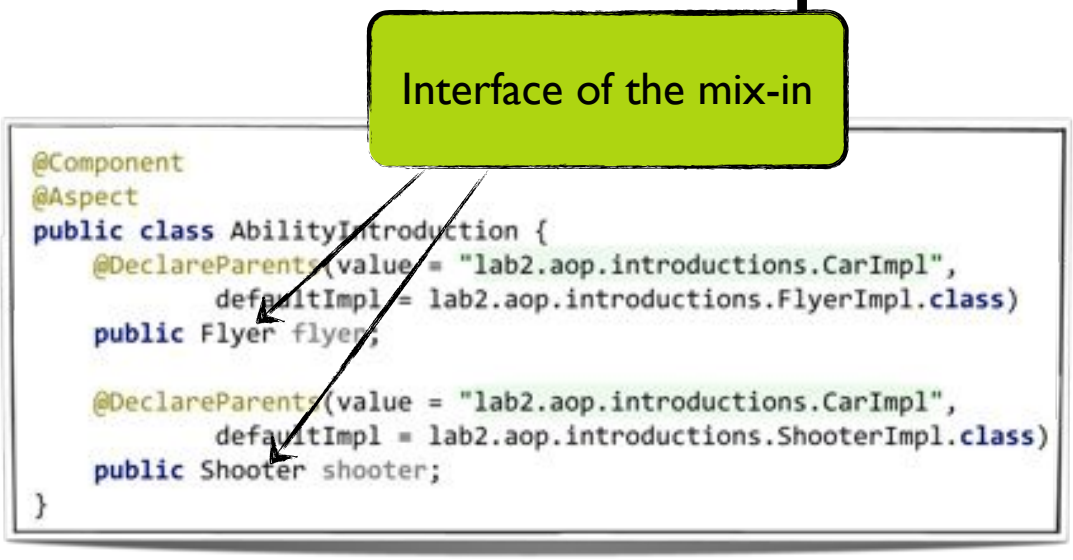
The plain car

```
@Component
public class CarImpl implements Car {
    @Override
    public void drive() {
        System.out.println("Driving...");
    }
}
```

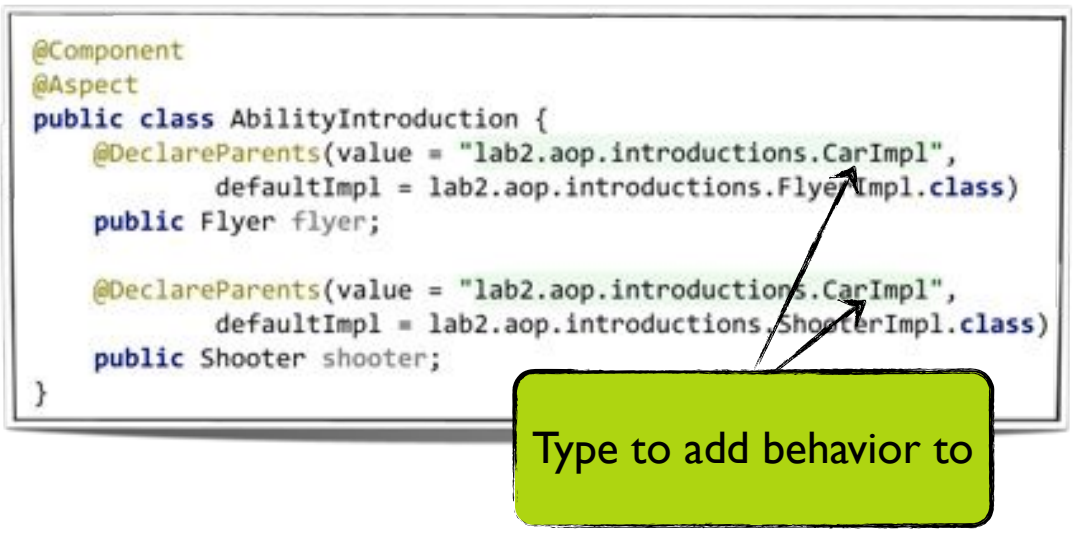

Introduction example

```
@Component
@Aspect
public class AbilityIntroduction {
    @DeclareParents(value = "lab2.aop.introductions.CarImpl",
            defaultImpl = lab2.aop.introductions.FlyerImpl.class)
    public Flyer flyer;

    @DeclareParents(value = "lab2.aop.introductions.CarImpl",
            defaultImpl = lab2.aop.introductions.ShooterImpl.class)
    public Shooter shooter;
}
```

Introduction example



Introduction example



Introduction example

Mix-in implementation

```
@Component
@Aspect
public class AbilityIntroduction {
    @DeclareParents(value = "lab2.aop.introductions.CarImpl",
            defaultImpl = lab2.aop.introductions.FlyerImpl.class)
    public Flyer flyer;

    @DeclareParents(value = "lab2.aop.introductions.CarImpl",
            defaultImpl = lab2.aop.introductions.ShooterImpl.class)
    public Shooter shooter;
}
```

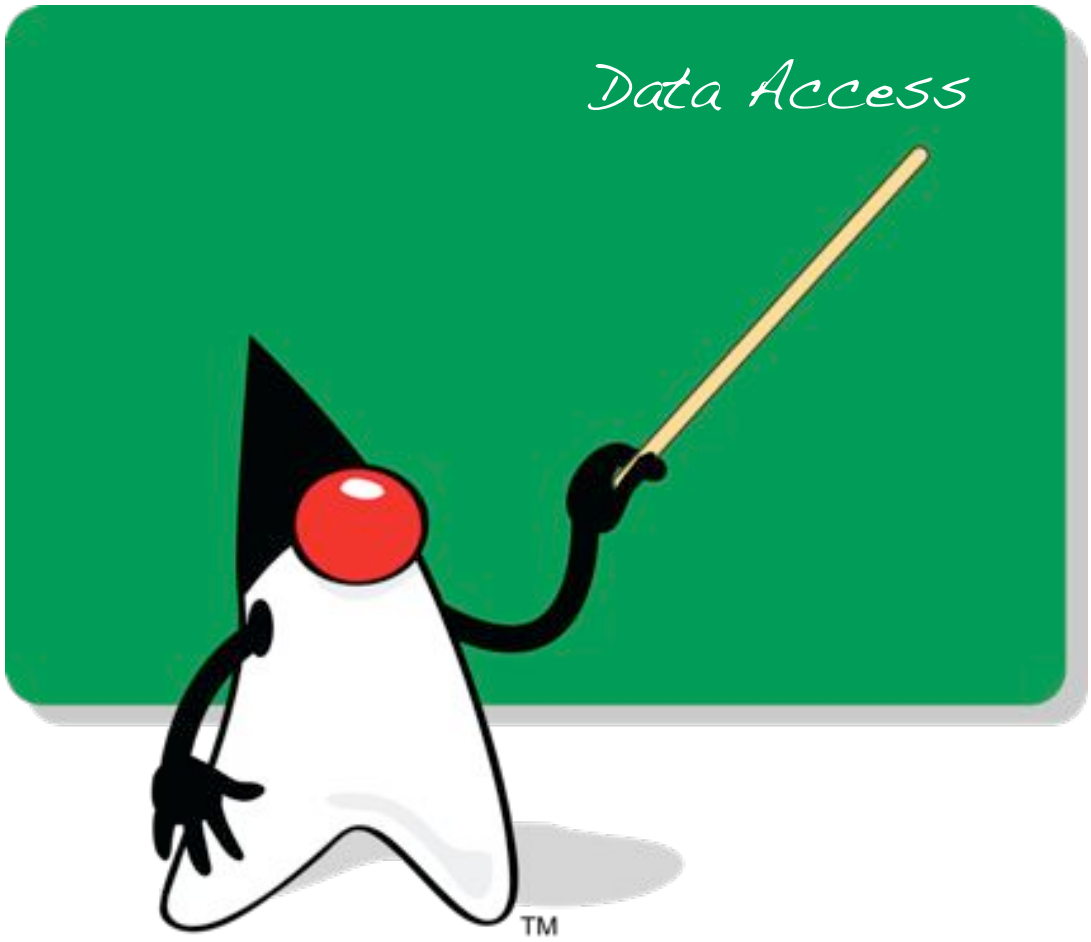

Introduction example

The car now implements Flyer and Shooter

```
Car car = ctx.getBean(Car.class);
car.drive();

Flyer flyer = (Flyer)car;
flyer.fly();

Shooter shooter = (Shooter)car;
shooter.shoot();
```

```
public class FlyerImpl implements Flyer {
    @Override
    public void fly() {
        System.out.println("Flying!");
    }
}
```

```
public class ShooterImpl implements Shooter {
    @Override
    public void shoot() {
        System.out.println("Shooting!");
    }
}
```



Data Access overview

- Declarative transaction management
- Exception handling
- Simplified JDBC support
- ORM integration

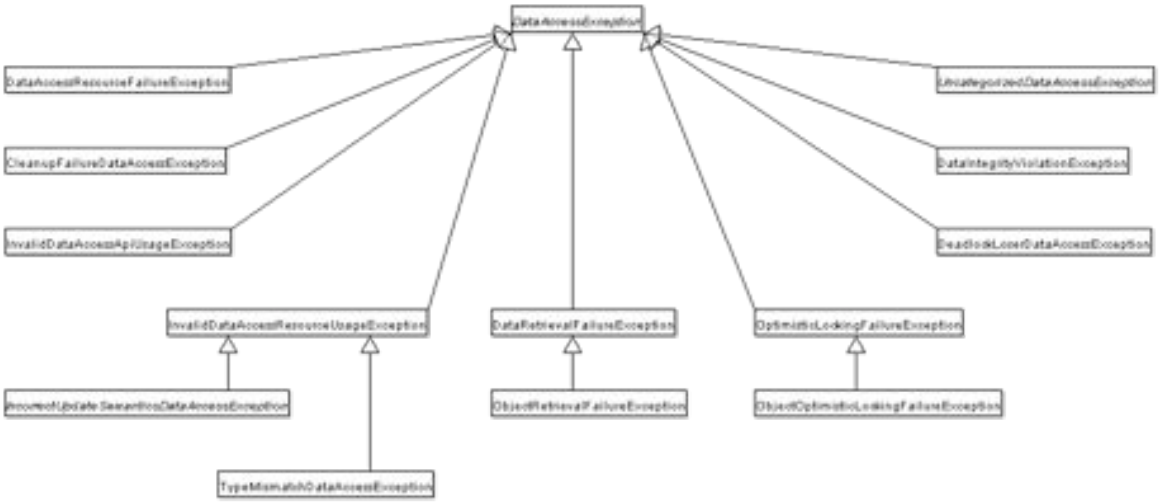
Things wrong with JDBC

- A lot of mandatory checked exception handling
  - most are not recoverable
- SQLException is very generic
  - have to parse the sql error-code yourself
- Clumsy API
  - simple things require a lot of code

Spring JDBC support

- Exception wrapping
  - all exceptions are translated to unchecked exceptions
- Consistent exceptions
  - native sql error codes are translated to consistent exception types
- Simplified APIs

Consistent Exception Hierarchy



Configuring a connection

Create a data source

```
<bean id="dataSource" class="org.apache.commons.dbcp.BasicDataSource"
      destroy-method="close">
    <property name="driverClassName" value="${jdbc.driverClassName}"/>
    <property name="url" value="${jdbc.url}"/>
    <property name="username" value="${jdbc.username}"/>
    <property name="password" value=""/>
</bean>

<context:property-placeholder location="classpath:jdbc.properties"/>
```

Lookup a data source

```
<jee:jndi-lookup jndi-name="myJndiDS"/>
```

Simple JDBC Template

- Creating a SimpleJdbcTemplate

```
private SimpleJdbcTemplate jdbcTemplate;

@Autowired
public void setDataSource(DataSource ds) {
    jdbcTemplate = new SimpleJdbcTemplate(ds);
}
```


Queries and mapping

Called for each row

```
public List<Movie> listMovies() {
    return jdbcTemplate.query("select * from movies",
            new RowMapper<Movie>() {

        @Override
        public Movie mapRow(ResultSet rs, int rowNum)
                throws SQLException {
            Movie movie = new Movie();
            movie.setTitle(rs.getString("title"));
            movie.setGenre(rs.getString("genre"));
            movie.setReleaseDate(rs.getDate("releaseDate"));

            return movie;
        }
    });
}
```

QueryForObject

```
public Movie findMovie(int id) {
    return jdbcTemplate.queryForObject("select * from movies where id = ?",
            new RowMapper<Movie>() {
                @Override
                public Movie mapRow(ResultSet rs, int i) throws SQLException {
                    Movie movie = new Movie();
                    movie.setTitle(rs.getString("title"));
                    movie.setGenre(rs.getString("genre"));
                    movie.setReleaseDate(rs.getDate("releaseDate"));

                    return movie;
                }
            }, id);
}
```


QueryFor...

- Convenience methods for several types

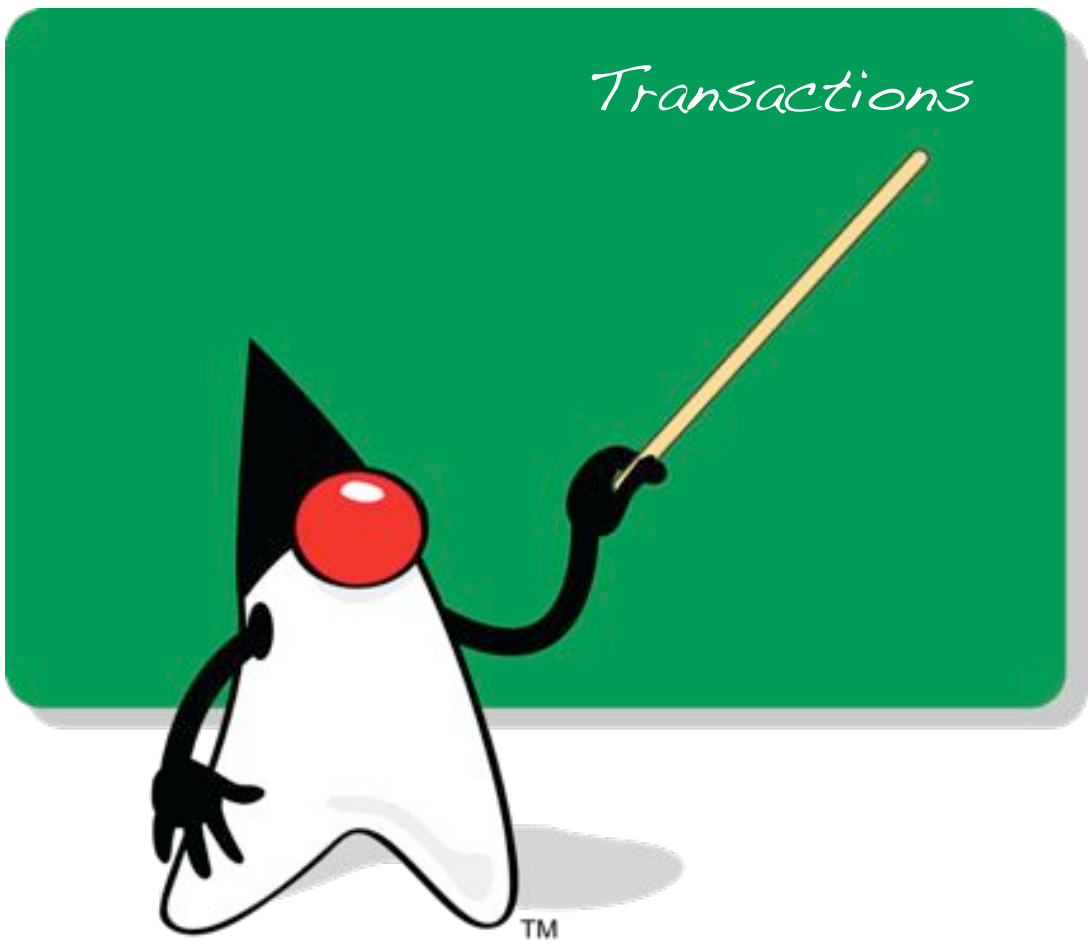
```
int nrOfRows = jdbcTemplate.queryForInt("select count(*) from movies");
```

Simple JDBC Insert

- Creating a SimpleJdbcInsert

```
private SimpleJdbcInsert simpleJdbcInsert;

@Autowired
public void setDataSource(DataSource ds) {
    simpleJdbcInsert = new SimpleJdbcInsert(ds).withTableName("movies")
            .usingGeneratedKeyColumns("id");
}
```

```
Map<String, Object> params = new HashMap<String, Object>();
params.put("title", movie.getTitle());
params.put("genre", movie.getGenre());
params.put("releasedate", movie.getReleaseDate());

return simpleJdbcInsert.executeAndReturnKey(params);
```

Transaction Management

- Consistent programming model across different technologies
  - JDBC, JPA, Hibernate etc.
  - Run JDBC and JPA code in the same transaction
- Declarative tx-management
- Simplified programmatic tx-management API

Creating a transaction manager

- Different transaction managers for different persistence solutions
  - DataSourceTransactionManager
  - HibernateTransactionManager
  - JpaTransactionManager
  - WebLogicJtaTransactionManager
  - WebSphereUowTransactionManager

Creating a transaction manager

JDBC transaction manager

```
<bean id="transactionManager"
      class="org.springframework.jdbc.datasource.DataSourceTransactionManager">
    <property name="dataSource" ref="dataSource"/>
</bean>
```

JPA transaction manager

```
<bean id="transactionManager"
      class="org.springframework.orm.jpa.JpaTransactionManager">
    <property name="entityManagerFactory" ref="myEmf"/>
</bean>
```


Declarative Transaction Management

Turn on annotation driven tx-management

```
<tx:annotation-driven transaction-manager="transactionManager"/>
```

Make each method transactional

Read only transaction

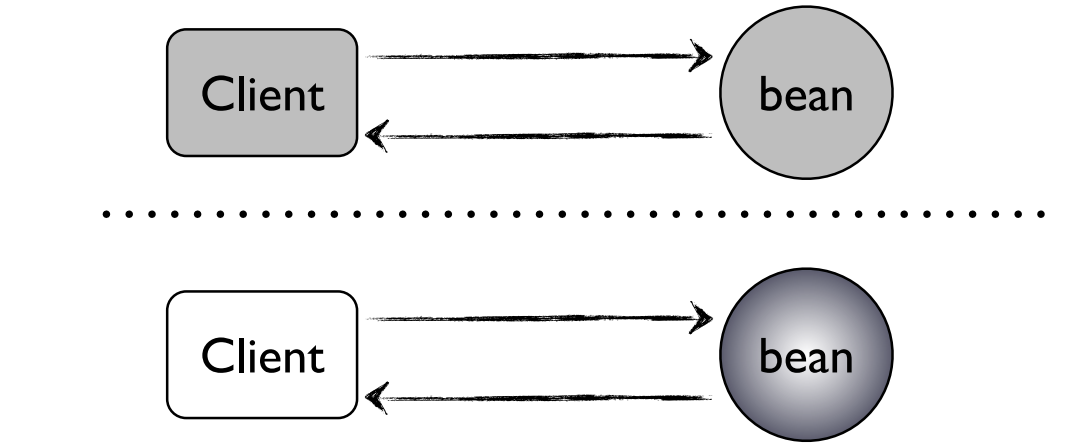
```
@Repository
@Transactional
public class ExampleDAO {
    public void saveContact(String name) {
        //Insert contact
    }

    @Transactional(readOnly = true)
    public List<String> listContacts() {
        //Query contact table
        return null;
    }
}
```

@Transactional

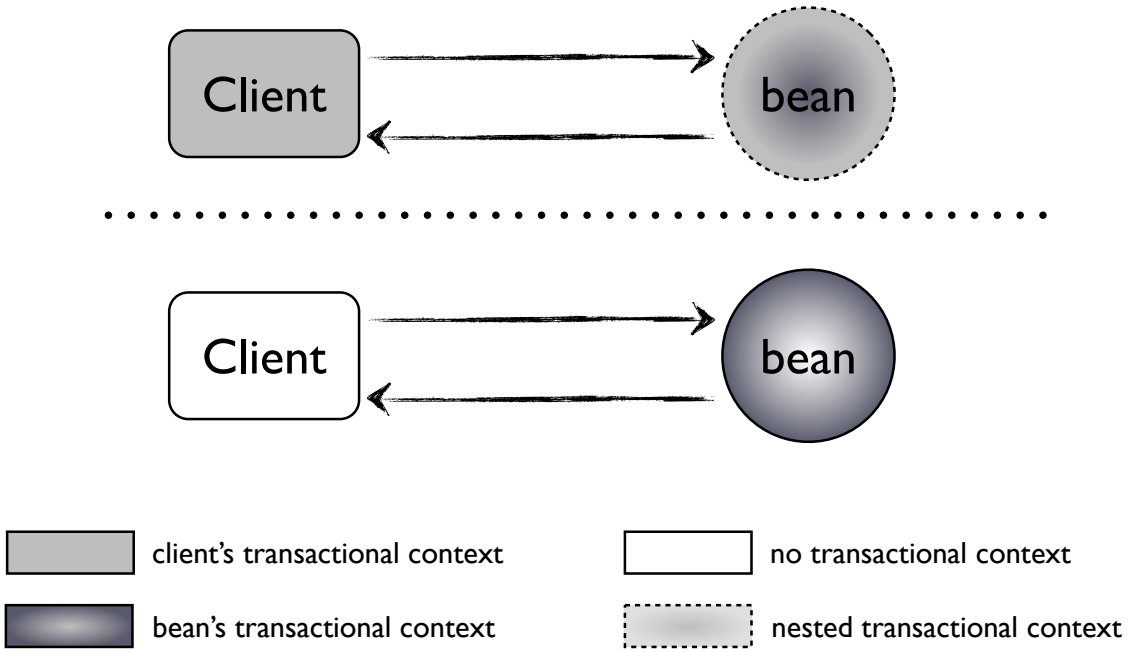
Attribute	Explanation
value	Optional qualifier specifying the tx-manager to use
propagation	Transaction propagation
isolation	Transaction isolation
read-only	Read/write or read-only transaction
rollbackFor	Array of Class objects that extends Throwable and should result in a rollback
noRollbackFor	Array of Class objects that extends Throwable and should not result in a rollback

Propagation

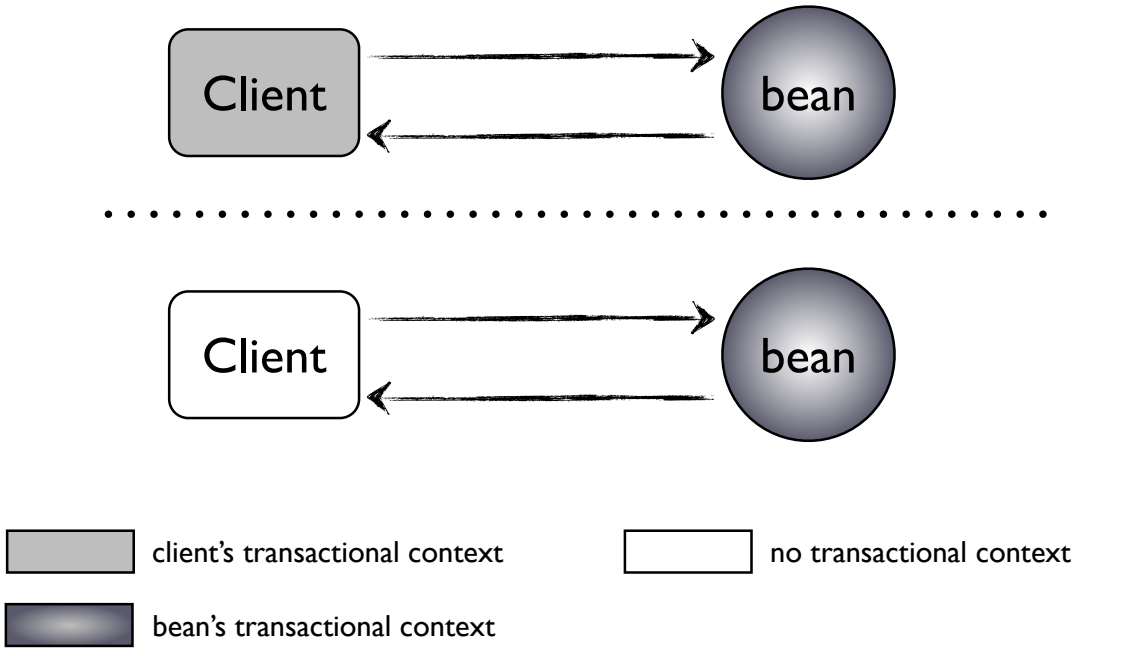
REQUIRED



Propagation
NESTED

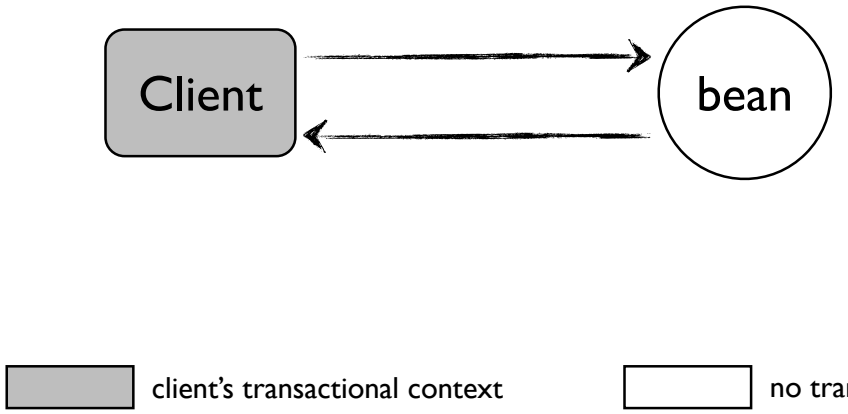


Propagation
REQUIRES_NEW



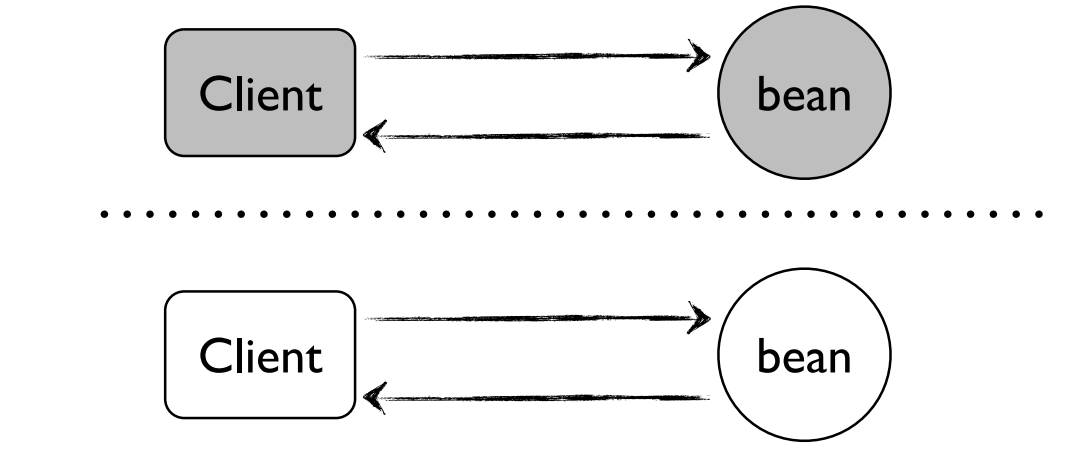
Propagation

NOT_SUPPORTED



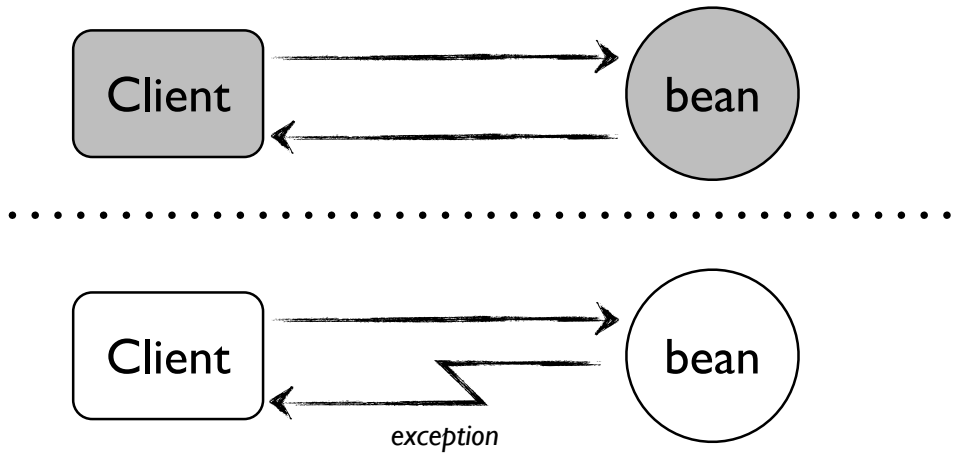
Propagation

SUPPORTS



Propagation

MANDATORY



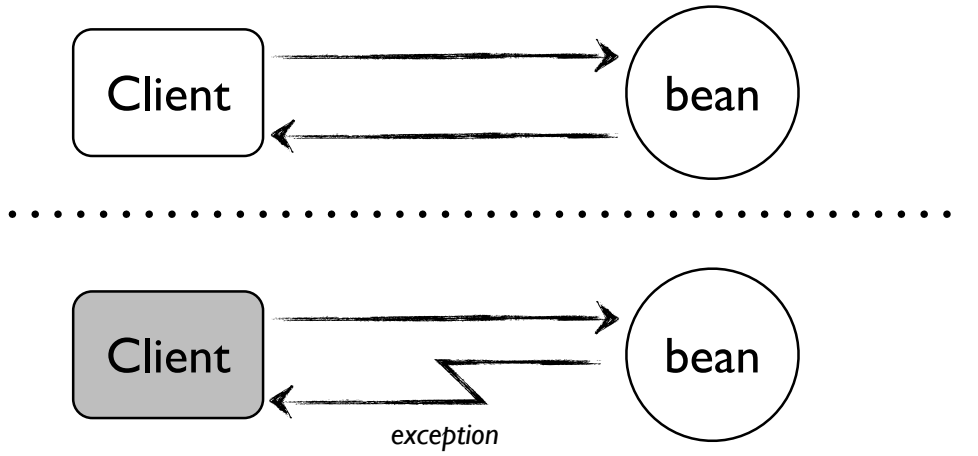
client's transactional context

no transactional context

bean's transactional context

Propagation

NEVER



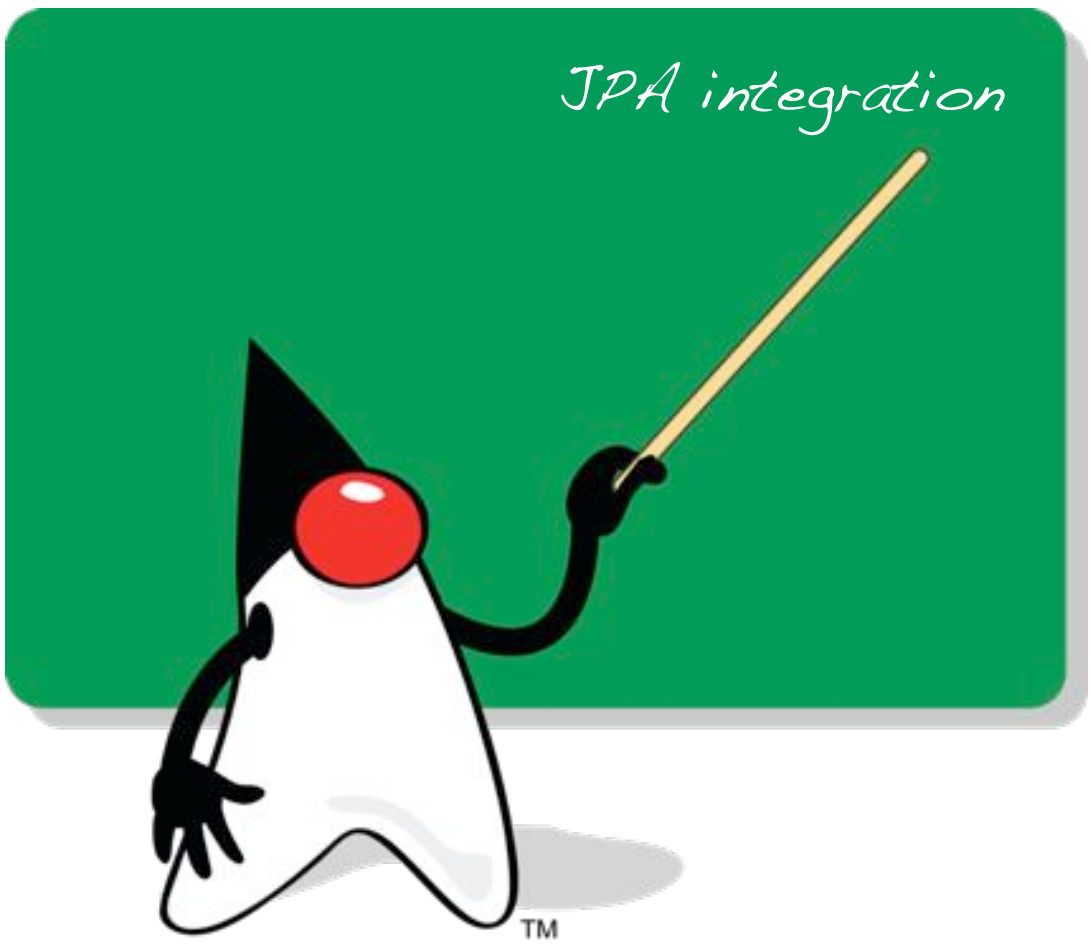
client's transactional context

no transactional context

bean's transactional context

Rollback behavior

- Exceptions bubbled up the stack are handled by Spring
- Transaction is rolled back for unchecked exceptions
  - probably an unrecoverable error
- Transaction is not rolled back for check exceptions
  - probably recoverable situation



Setting up JPA

- Create a META-INF/persistence.xml file
- Configure an EntityManagerFactory
- Configure a JpaTransactionManager
- Configure the JPA dialect in Spring

persistence.xml

```
<persistence-unit name="testPU" transaction-type="RESOURCE_LOCAL">
    <provider>org.hibernate.ejb.HibernatePersistence</provider>
    <properties>
        <property name="hibernate.show_sql" value="true" />
        <property name="hibernate.format_sql" value="true" />
        <property name="hibernate.dialect"
                  value="org.hibernate.dialect.MySQL5InnoDBDialect" />
        <property name="hibernate.hbm2ddl.auto" value="update" />
    </properties>
</persistence-unit>
```

Configuring JPA

```
<bean id="myEmf"
      class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
    <property name="dataSource" ref="dataSource"/>
    <property name="jpaDialect" ref="jpaDialect"/>
</bean>

<bean id="jpaDialect"
      class="org.springframework.orm.jpa.vendor.HibernateJpaDialect"/>

<bean id="transactionManager"
      class="org.springframework.orm.jpa.JpaTransactionManager">
    <property name="entityManagerFactory" ref="myEmf"/>
</bean>
```


Using JPA

Inject an EntityManager

```
@PersistenceContext
EntityManager em;
```

Plain JPA usage with declarative transactions

```
@SuppressWarnings("unchecked")
@Transactional(readOnly=true)
public List<Book> listBooks() {
    Query q = em.createQuery("select b from Book b");
    return q.getResultList();
}
```

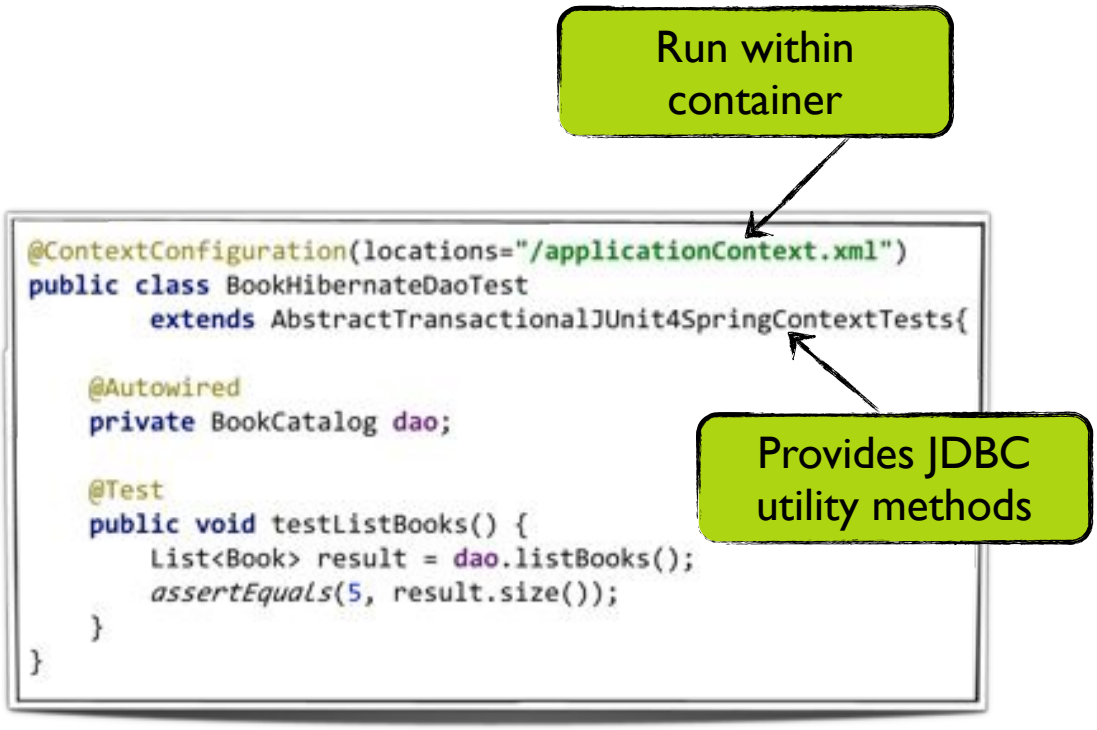
Templates and DaoSupport

- Several Template and DaoSupport classes exists
  - similar to JdbcTemplate
- Not necessary any more because JPA API is already easy to use
- Prefer plain JPA API

Testing DAOs

- Unit testing doesn't make sense
  - queries can only be tested with a real database
- Run automated tests within a Spring container

Testing DAOs



Testing DAOs

- Transactions are rolled back after each test by default
  - no need to re-insert test data for each test
- Test JPA code using JDBC queries

```
@Test
public void testSaveBook() {
    Book book = new Book();
    book.setTitle("Harry Potter");
    int books = countRowsInTable("Book");
    dao.saveBook(book);
    assertEquals(books + 1, countRowsInTable("Book"));
}
```

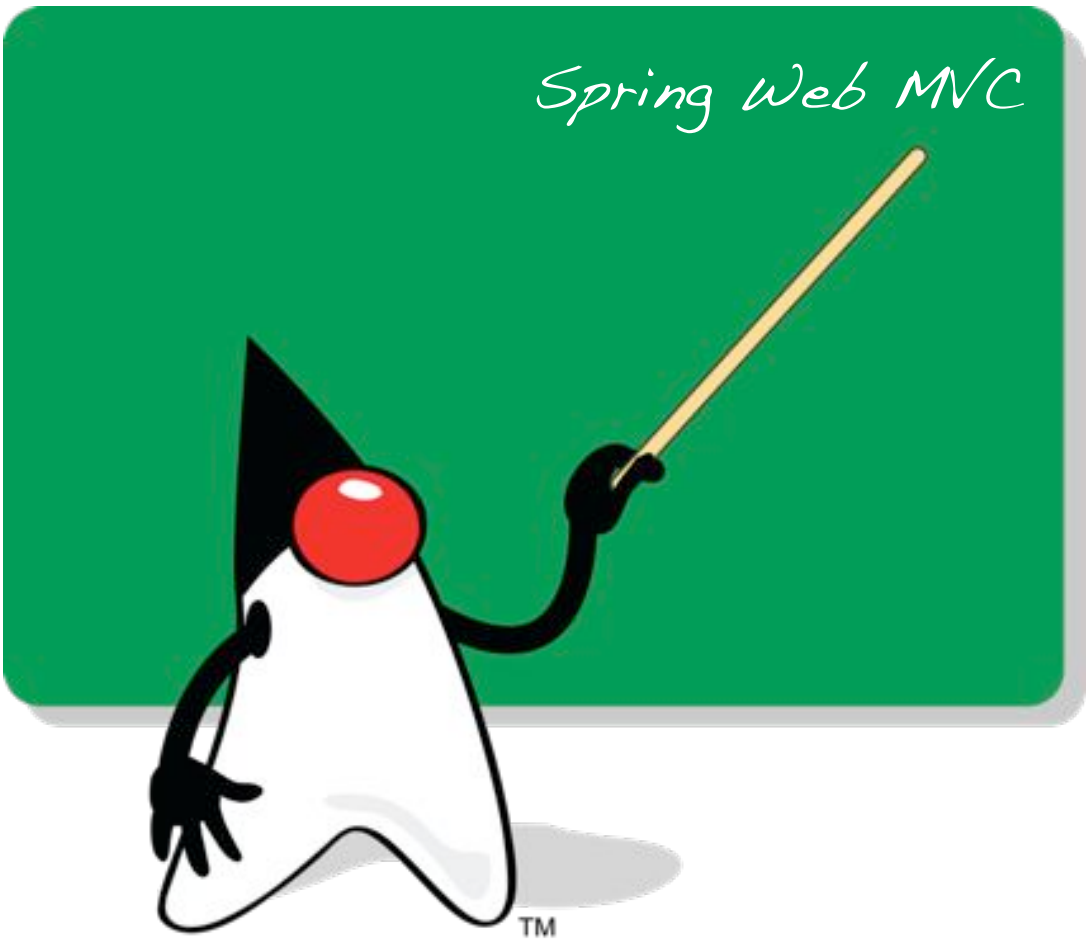
Disable default rollback behavior

Don't roll back transactions for any method

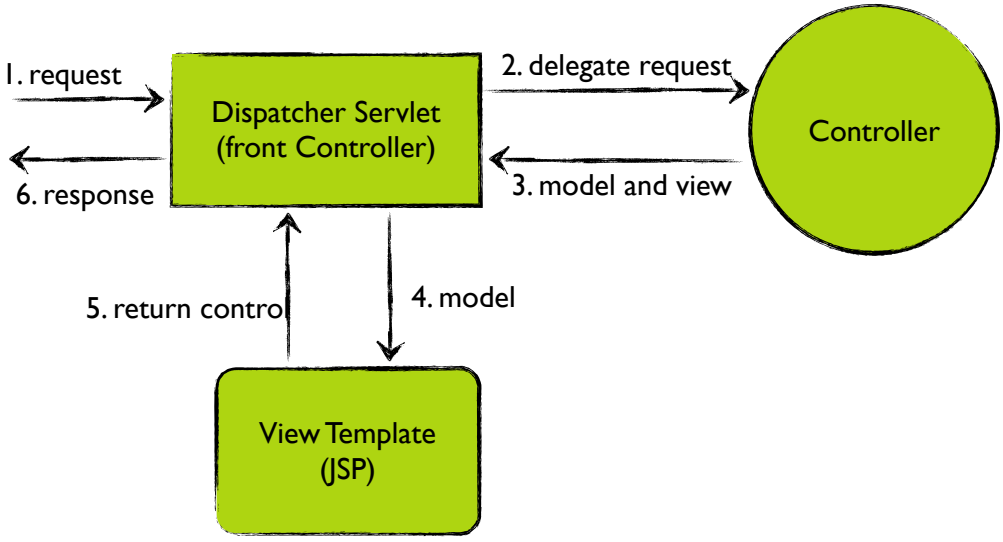
```
@ContextConfiguration(locations="/applicationContext.xml")
@TransactionConfiguration(defaultRollback = false)
public class BookHibernateDaoTest
        extends AbstractTransactionalJUnit4SpringContextTests{
```

Don't roll back transactions for this method

```
@Test @Rollback(false)
public void testSaveBook() {
```

Handling requests



Configuring Web MVC

Add the Dispatcher Servlet to web.xml

Needs a `WEB-INF/spring-servlet.xml` config file

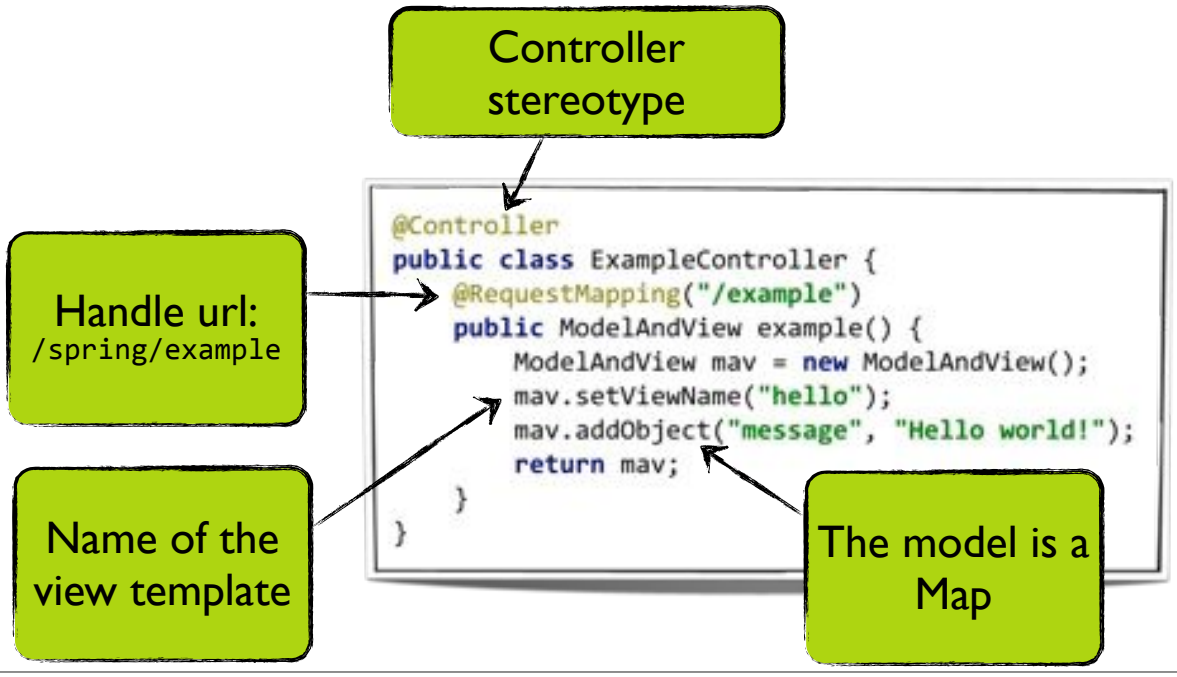
```
<servlet>
    <servlet-name>spring</servlet-name>
    <servlet-class>
        org.springframework.web.servlet.DispatcherServlet
    </servlet-class>
    <load-on-startup>1</load-on-startup>
</servlet>

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

Additional configuration files

web.xml

```
<context-param>
    <param-name>contextConfigLocation</param-name>
    <param-value>/WEB-INF/applicationContext.xml
        /WEB-INF/applicationContext-security.xml
    </param-value>
</context-param>

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


Implementing controllers



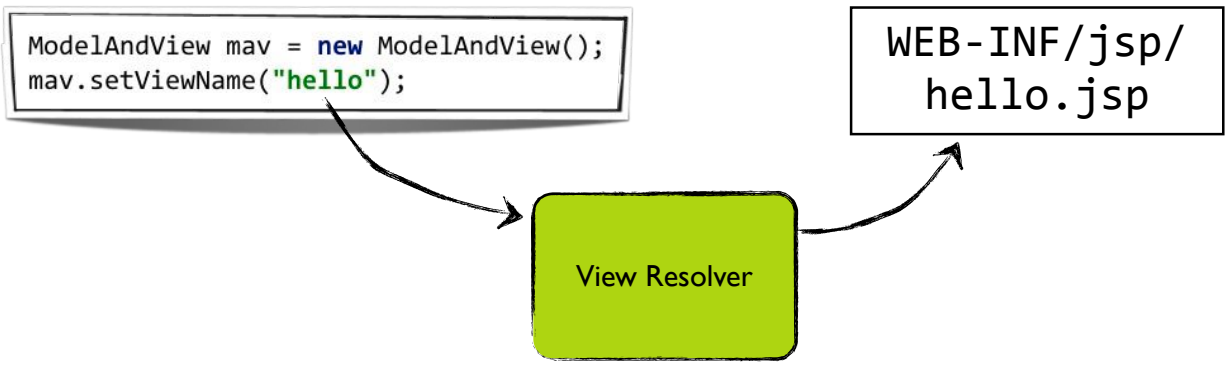
JSP page

- Use Expression Language to render model values
- Use JSTL and Spring tags to make pages dynamic

```
<html>
    <body>
        ${message}
    </body>
</html>
```


View resolvers

- View names are resolved to views using view resolvers



Most useful View resolvers

View resolver	Explanation
`InternalResourceViewResolver`	Servlet and JSP view resolver. View names are prefixed and suffixed to generate file name
`ResourceBundleViewResolver`	Views are defined in views.properties. Supports multiple kinds of views working together (e.g. JSP and Excel)
`ContentNegotiatingViewResolver`	Resolve views based on the *accept* header in the HTTP request. Useful for RESTful web services

There are more view resolvers, but are less likely to be used

Resolving JSP views

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

Creating PDF documents

```
public class MyPdfView extends AbstractPdfView{
    @Override
    protected void buildPdfDocument(
            Map<String, Object> model,
            com.lowagie.text.Document document,
            com.lowagie.text.pdf.PdfWriter pdfWriter,
            HttpServletRequest httpServletRequest,
            HttpServletResponse httpServletResponse) throws Exception {
        document.add(new Paragraph((String)model.get("message")));
    }
}
```


Resolving PDF views

```
<bean id="pdfViewResolver"
      class="org.springframework.web.servlet.view.ResourceBundleViewResolver">
    <property name="order" value="1"/>
    <property name="basename" value="views"/>
</bean>
```

views.properties

```
mypdf.(class)=dvdstore.views.MyPdfView
```

controller

```
ModelAndView mav = new ModelAndView();
mav.setViewName("mypdf");
```

URI Templates

- URLs can contain variable data
  - `/products/{productId}`
  - `/products/{category}/all`
- Use parameter in request handling

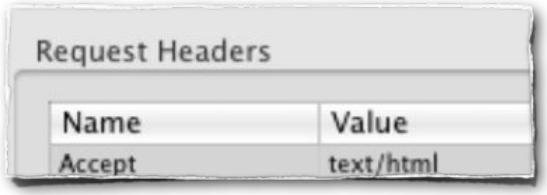
```
@RequestMapping("products/{productId}")
public ModelAndView productDetails(@PathVariable int productId) {
    ModelMap model = new ModelMap();
    model.addAttribute("productId", productId);
    return new ModelAndView("product", model);
}
```


Accessing request parameters

- `/search?query=Spring`

```
@RequestMapping("search")
public void search(@RequestParam(required = true) String query) {
    System.out.println("Query: " + query);
}
```

Accessing request headers




```
@RequestMapping("/example")
public ModelAndView example(@RequestHeader String accept) {
    System.out.println("Accept header: " + accept);
```


Accessing request cookies

```
@RequestMapping("/example")
public ModelAndView example(@CookieValue String userId) {
    System.out.println("Cookie value: " + userId);
```

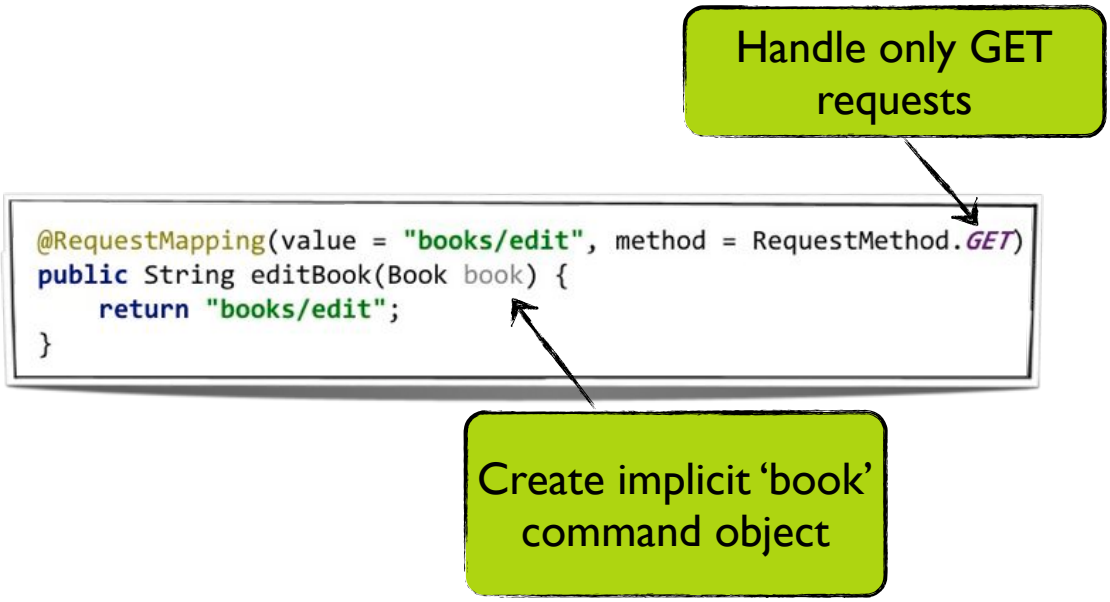
Request method arguments

View resolver	Explanation
`@RequestBody`	The body of the request mapped by a HttpMessageConverter (for RESTful web services)
`HttpServletRequest / HttpServletResponse`	Plain Servlet API request and response
`HttpSession`	The Servlet API session object (think about thread safety)
`Locale`	The current request's locale
`InputStream / Reader`	Raw inputstream to access the request's content
`OutputStream / Write`	Raw outputstream to write response content
`Map / Model / ModelMap`	Implicit model that's exposed to the web view
`Command objects`	Command objects available in the model
`Errors / BindingResult`	Validation results for the preceding command object
`SessionStatus`	Status handle for marking form processing complete, triggering session cleanup

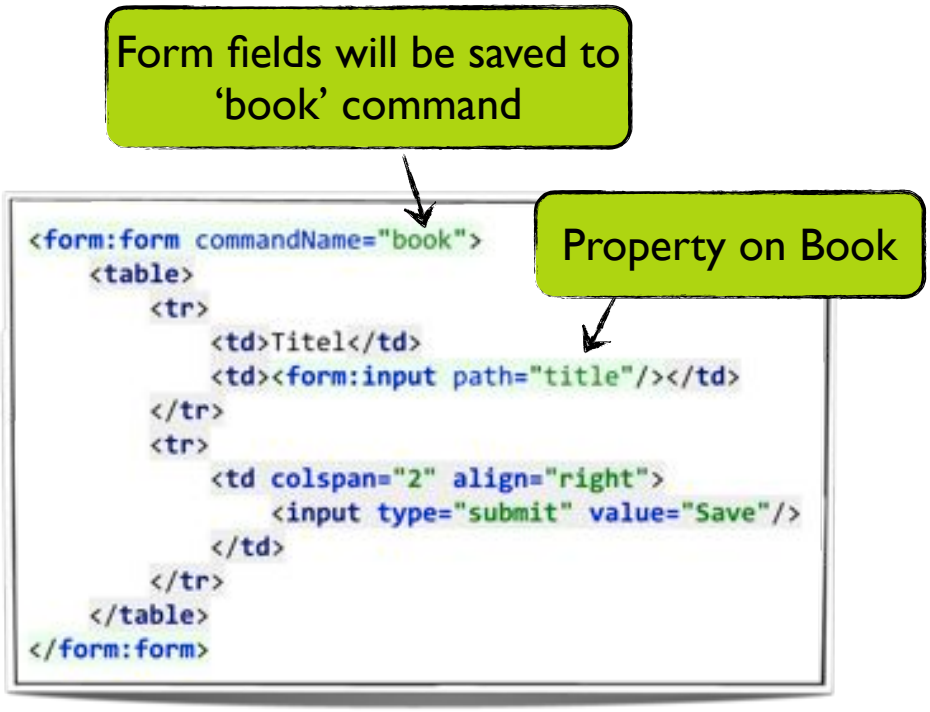
Request method return types

View resolver	Explanation
`ModelAndView`	Combination of explicit model and view object
`Model / Map`	View name is resolved using the `RequestToViewNameTranslator`
`View`	Model resolved using implicit model command objects
`String`	View name. Model is resolved using implicit model command objects
`Void`	Model resolved using implicit model command objects. View name is resolved using the `RequestToViewNameTranslator`
`@ResponseBody`	Object converted using a HttpMessageConverter. Useful for RESTful web services

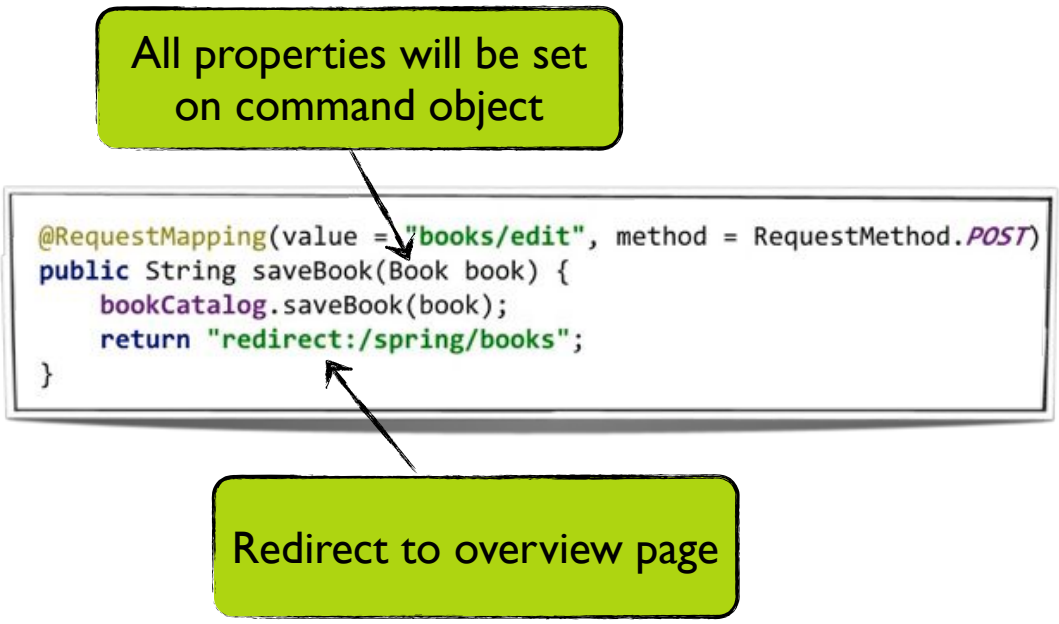
Showing a form



HTML Form



Submitting a form



Bean Validation

- Bean Validation API (JSR-303)
- Define field constraints on Java classes
- Integrates with other frameworks
  - e.g. JSF 2.0, Spring 3, JPA 2

Validation Example

```
@Entity
public class Employee {
    @Id
    private Long id;

    @NotNull @Size(min = 2, max = 20)
    private String name;

    @Past
    private Date birthDate;

    @Min(value = 1000)
    private double salary;
```

- @Null
- @NotNull
- AssertTrue
- AssertFalse
- @Min
- @Max
- @DecimalMin
- @DecimalMax
- @Size
- @Digits
- @Past
- @Future
- @Pattern

Triggering validation

Trigger bean validation

```
@RequestMapping(value = "employees/edit", method = RequestMethod.POST)
public String saveBook(@Valid Employee employee,
                       BindingResult result) {
    if (result.hasErrors()) {
        return "employee/addForm";
    } else {
        //Save employee
        System.out.println("Employee: " + employee.getFirstname());
        return "redirect:/spring/employees";
    }
}
```

Contains error information

Rendering validation errors

```
<form:form commandName="employee">

    <spring:hasBindErrors name="employee">
            <span style="color:red;">
            Er zijn validatiefouten.
            </span>
    </spring:hasBindErrors>

    <table>
        <tr>
            <td>Titel</td>
            <td><form:input path="firstname"/>
                    <span style="color:red;">
                      <form:errors path="firstname"/>
                    </span>
            </td>
        </tr>
```

Check if there are binding errors

Render error for specific property

Custom bean validation invocation

```
validator.validate(Object instance, Class<?>... groups)
```

```
ValidatorFactory factory = Validation.buildDefaultValidatorFactory();
Validator validator = factory.getValidator();

Set<ConstraintViolation<Employee>> violations =
        validator.validate(emp1, Communicating.class);

for (ConstraintViolation<Employee> violation : violations) {
    System.out.println("Error: " + violation.getMessage());
}
```

Creating constraints

- Create annotation
- Implement validator class

```
@ElementCollection
@NonEmptyCollection
private Set<String> emailAddresses;
```

```
@Retention(RetentionPolicy.RUNTIME)
@Target({ElementType.METHOD, ElementType.FIELD})
@Constraint(validatedBy = NonEmptyCollectionValidator.class)
public @interface NonEmptyCollection {
    String message() default "Collection may not be empty";
    Class<?>[] groups() default {};
    Class<? extends Payload>[] payload() default {};
}
```


Creating constraints

```
public class NonEmptyCollectionValidator implements
        ConstraintValidator<NonEmptyCollection, Collection<?>> {
    @Override
    public void initialize(NonEmptyCollection nonEmptyCollection) {

    }

    @Override
    public boolean isValid(Collection<?> objects,
                           ConstraintValidatorContext
                                   constraintValidatorContext) {
        return objects != null && objects.size() > 0;
    }
}
```

Validation Groups

- Define different sets of constraints for different situations
- Trigger validation only for a certain constraints

```
@ElementCollection
@NonEmptyCollection(groups = Communicating.class)
private Set<String> emailAddresses;
```

```
public interface Communicating {
}
```

```
validator.validate(emp1, Communicating.class);
```


Checkbox tag

```
<form:checkbox path="fulltime" />
```

```
private boolean fulltime;

public boolean getFulltime() {
    return fulltime;
}

public void setFulltime(boolean fulltime) {
    this.fulltime = fulltime;
}
```

Select & options tags

Render from an Enum

```
<form:select path="gender">
    <form:options/>
</form:select>
```

```
private Gender gender;

public Gender getGender() {
    return gender;
}

public void setGender(Gender gender) {
    this.gender = gender;
}
```

```
public enum Gender {
    MALE, FEMALE
}
```


Select & options tags

```
<form:select path="sex">
    <form:option value="M" label="Male"/>
    <form:option value="F" label="Female"/>
</form:select>
```

```
private String sex;

public String getSex() {
    return sex;
}

public void setSex(String sex) {
    this.sex = sex;
}
```

Radiobuttons tag

```
<form:radiobuttons path="role" items="${roles}"/>
```

```
private String role;

public String getRole() {
    return role;
}

public void setRole(String role) {
    this.role = role;
}
```

Method to produce model attributes

```
@ModelAttribute("roles")
public List<String> listRoles() {
    return Arrays.asList("Developer", "Sales", "Management");
}
```


Binders

```
@InitBinder
public void initBinder(WebDataBinder binder) {
    SimpleDateFormat dateFormat = new SimpleDateFormat("yyyy-MM-dd");
    dateFormat.setLenient(false);
    binder.registerCustomEditor(
            Date.class,
            new CustomDateEditor(dateFormat, false));
}
```

```
private Date birthdate;

public Date getBirthdate() {
    return birthdate;
}

public void setBirthdate(Date birthdate) {
    this.birthdate = birthdate;
}
```

```
<form:input path="birthdate"/>
```

Uploading files

```
<form:form commandName="employee"
           enctype="multipart/form-data">
    <input type="file" name="icon"/>
```

```
<bean id="multipartResolver"
      class="org.springframework.web.multipart.commons.CommonsMultipartResolver">
    <property name="maxUploadSize" value="100000"/>
</bean>
```

```
@RequestMapping(value = "employees/edit", method = RequestMethod.POST)
public String saveBook(@Valid Employee employee,
                       BindingResult result,
                       @RequestParam("icon") MultipartFile file) {

    System.out.println("File: " + file.getOriginalFilename());
```


Handling exceptions

Map exceptions to custom error pages

```
<bean class="...SimpleMappingExceptionResolver">
    <property name="defaultErrorView" value="error"/>
    <property name="exceptionMappings">
        <util:map>
            <entry key="dvdstore.controllers.MyCustomException"
                   value="customerror"/>
        </util:map>
    </property>
</bean>
```

Handling exceptions

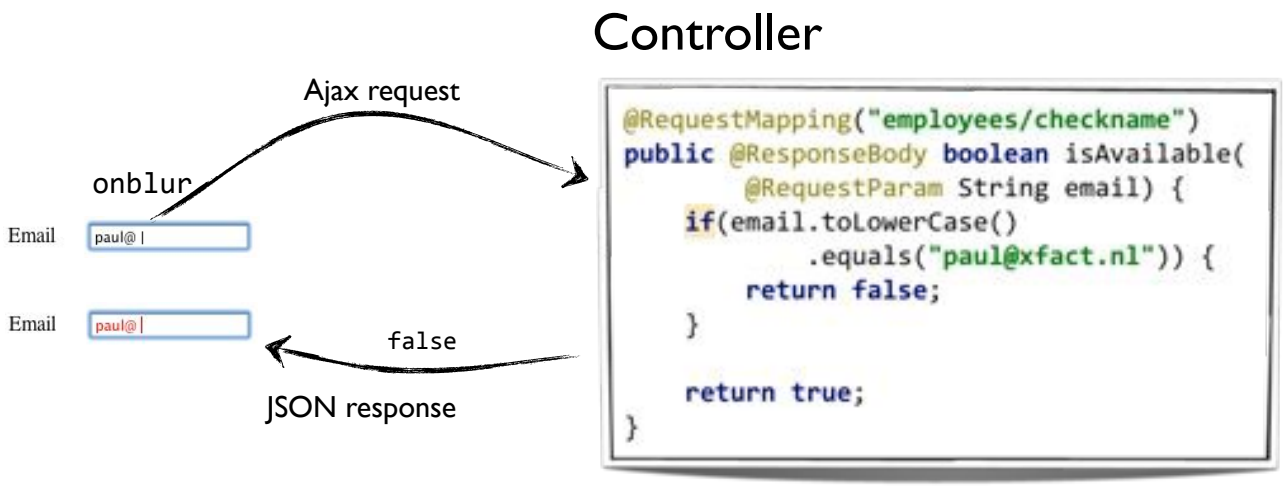
Handle exceptions from code

```
@Component
public class CustomErrorResolver
        implements HandlerExceptionResolver {
    @Override
    public ModelAndView resolveException(HttpServletRequest request,
                                         HttpServletResponse response,
                                         Object handler,
                                         Exception ex) {
        if (ex instanceof MyCustomException) {
            return new ModelAndView("customerror");
        } else {
            return new ModelAndView("error");
        }
    }
}
```


Two types of Ajax

- Data centric
  - server sends back JSON
  - client does all the rendering
- Content centric
  - server sends back HTML
  - client just places the new content in the page

Data centric Ajax



jQuery example

```
<script type="text/javascript">
    $(document).ready(function() {
        $("#email").blur(function() {
            $.getJSON("checkname", {
                email: $("#email").val()
            },
            function(availability) {
                if(!availability) {
                    $("#email").addClass('error');
                }

            });

        });
    });

</script>
```

Interceptors

- Intercept requests before handling
- Similar to Servlet Filters but within the Spring context
- Implement *`HandlerInterceptor`* interface
  - or extend *`HandlerInterceptorAdaptor`* convenience class

Interceptor example

```
public class TimeBasedAccessInterceptor extends
        HandlerInterceptorAdapter {

    @Override
    public boolean preHandle(HttpServletRequest request,
                             HttpServletResponse response,
                             Object handler) throws Exception {
        //implement intercepter logic here
        if (1 > 2) {
            return true;
        } else {
            response.setStatus(403);
            return false;
        }

    }
}
```

Configuring interceptors

```
<mvc:interceptors>
    <bean class="...TimeBasedAccessInterceptor"/>

    <bean class="...ThemeChangeInterceptor">
        <property name="paramName" value="theme"/>
    </bean>

    <bean class="...LocaleChangeInterceptor">
        <property name="paramName" value="lang"/>
    </bean>
</mvc:interceptors>
```


Localization

- Retrieve locale from browser

```
<bean id="localeResolver"
      class="...AcceptHeaderLocaleResolver"/>
```

- Retrieve locale from cookie

```
<bean id="localeResolver"
      class="...CookieLocaleResolver"/>
```

Localization

- Set locale from request parameter
  - e.g. /products?lang=nl
- Can't be used with Accept Header

```
<mvc:interceptors>
    <bean class="...LocaleChangeInterceptor">
      <property name="paramName" value="lang"/>
    </bean>
</mvc:interceptors>
```


Themes

- Themes allow retrieving stylesheet names etc. from property files

```
<link rel="stylesheet" href="<spring:theme code='css'/>" type="text/css"/>
```

black.properties

```
css=/css/black.css
```

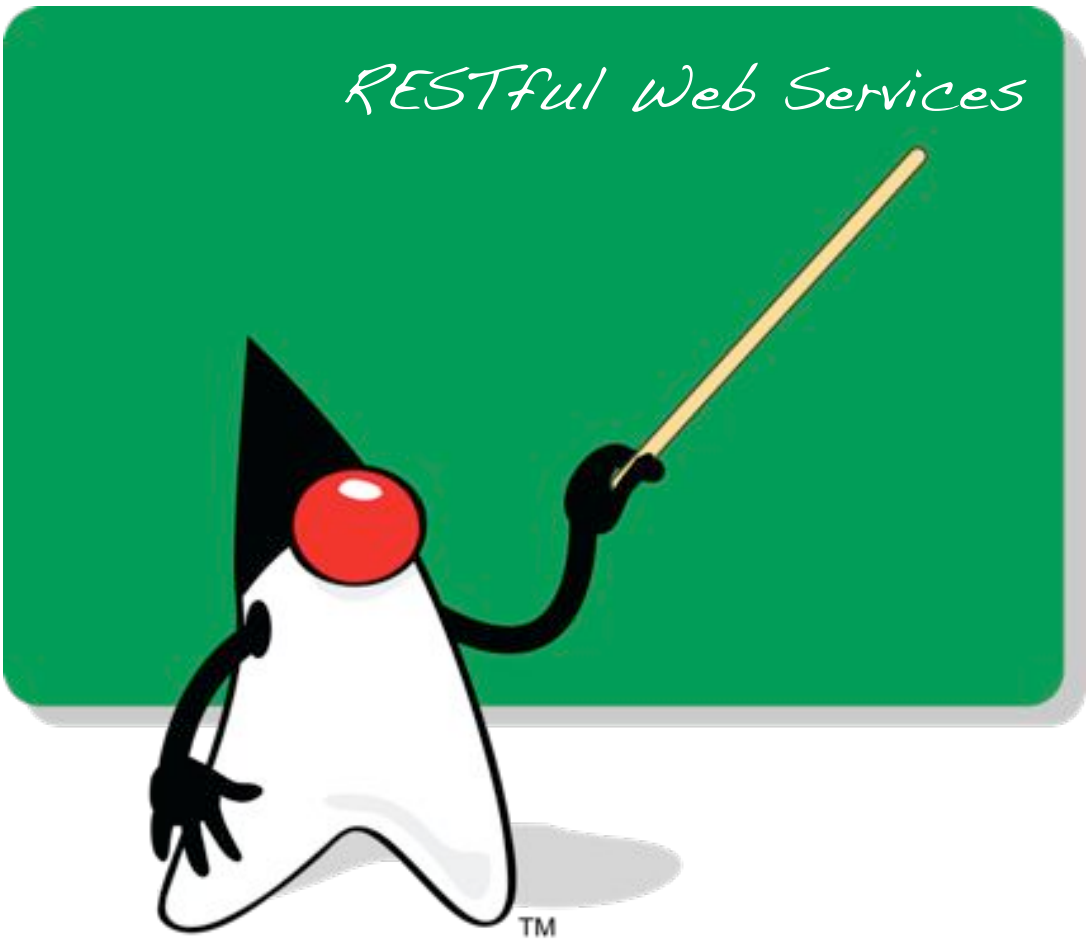
white.properties

```
css=/css/white.css
```

Resolving themes

```
<bean name="themeResolver" class="...CookieThemeResolver">
    <property name="defaultThemeName" value="white"/>
</bean>
```

```
<mvc:interceptors>
    <bean class="...ThemeChangeInterceptor">
        <property name="paramName" value="theme"/>
    </bean>
</mvc:interceptors>
```

REST fact sheet

- **RE**presentational **S**tate **T**ransfer
- Introduced by Roy Fielding
  - Dissertation in 2000
  - An architectural style for distributed systems
- HTTP is an example of REST

RESTful web services

- Services implemented conform the REST principles
- Mostly based at HTTP

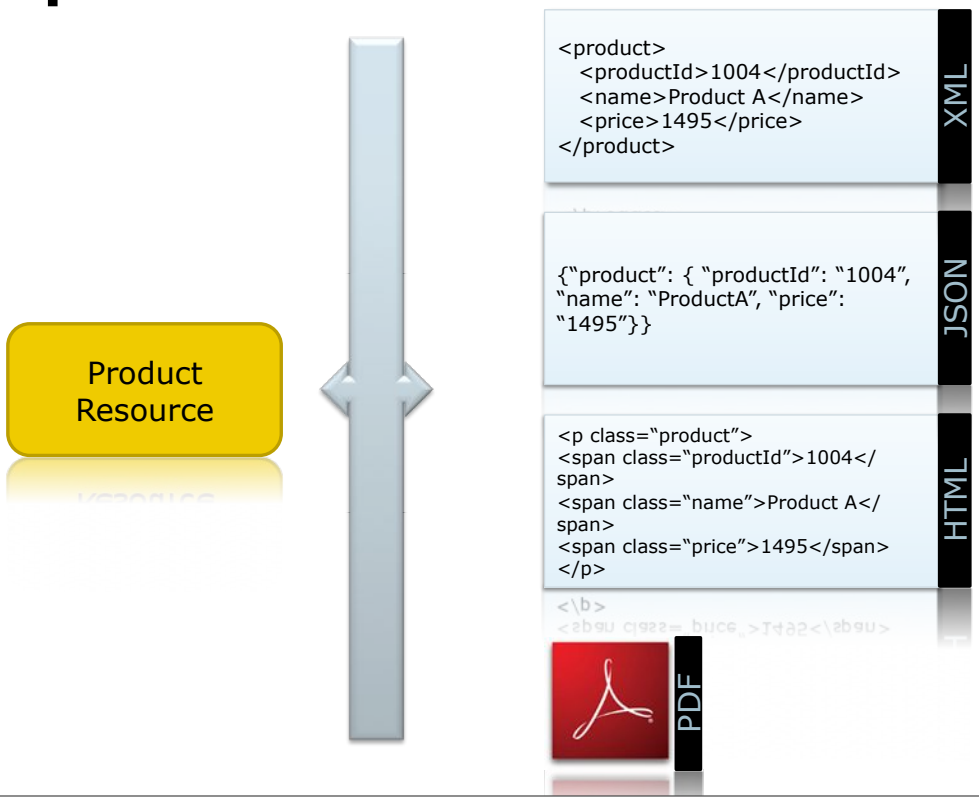
The REST hype

- More public web APIs
  - Google, Amazon, Flickr etc.
- Popularity of lightweight web frameworks
  - Rails / Grails
- People are tired of WSDL
- XML is not always the best format

Everything is a resource

- A list of books
- A product
- A list of search results
- An order

Representations



HTTP content negotiation

- A client can ask for specific formats
- The accept header
  - Accept: "application/xml"

Dynamic resources

- A resource can be ‘static’
  - A record in your database
  - A file
- A resource can be ‘dynamic’
  - Calculated results
  - Generated data

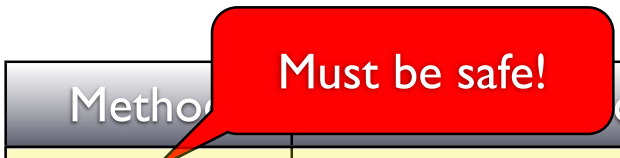
RESTful properties

- Uniform Interface
- Addressability
- Connectedness
- Statelessness

Uniform Interface

Method	Description
GET	Retrieve a resource representation
PUT	Add or modify a resource with a specified URI
DELETE	Delete a resource
HEAD	GET without body: "Does this resource exists?"
POST	Overloaded: implementation may vary. Might generate a new URI

Uniform Interface



Metho	cription
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Uniform Interface

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Addressability

Each resource has a Unique Resource Identifier (URI)

- /products
- /product/{id} => /product/10
- /products?color=red
- /search?q=jax-rs

Connectedness

- Navigate from one resource to another
- Clients do not generate URIs
- One of the most important WEB concepts
  - Hyperlinks

Not connected: How do I get product information?

```
<searchresult>
   <product name="Product 1"/>
   <product name="Product 2"/>
   <product name="Product 3"/>
   <product name="Product 4"/>
</searchresult>
```


Connected: Linked to more information

```
<searchresult>
   <product name="Product 1" url="http://myservice/product/1"/>
   <product name="Product 2" url="http://myservice/product/2"/>
   <product name="Product 3" url="http://myservice/product/3"/>
   <product name="Product 4" url="http://myservice/product/4"/>
</searchresult>
```

Back to the SOAP age

A SOAP product service

/ProductService

- API
  - saveProduct
  - getProduct
  - deleteProduct
  - getAllProducts
  - searchProducts


```
<definitions targetNamespace="http://demo/" name="ProductServiceService" xmlns="http://
schemas.xmlsoap.org/wsdl/" xmlns:wsp="http://schemas.xmlsoap.org/ws/2004/09/policy"
xmlns:tns="http://demo/" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:soap="http://
schemas.xmlsoap.org/wsdl/soap/" xmlns:wsu="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-
wssecurity-utility-1.0.xsd">
<types>
  <xsd:schema>
    <xsd:import namespace="http://demo/" schemaLocation="ProductServiceService_schema1.xsd"/>
  </xsd:schema>
</types>
<message name="addProduct">
  <part name="parameters" element="tns:addProduct"/>
</message>
<message name="addProductResponse">
  <part name="parameters" element="tns:addProductResponse"/>
</message>
<portType name="ProductService">
  <operation name="addProduct">
    <input message="tns:addProduct"/>
    <output message="tns:addProductResponse"/>
  </operation>
</portType>
<binding name="ProductServicePortBinding" type="tns:ProductService">
  <soap:binding transport="http://schemas.xmlsoap.org/soap/http" style="document"/>
  <operation name="addProduct">
    <soap:operation soapAction=""/>
    <input>
      <soap:body use="literal"/>
    </input>
    <output>
      <soap:body use="literal"/>
    </output>
  </operation>
</binding>
<service name="ProductServiceService">
  <port name="ProductServicePort" binding="tns:ProductServicePortBinding">
    <soap:address location="REPLACE_WITH_ACTUAL_URL"/>
  </port>
</service>
```

Does this feel like the web?

The RESTful alternative

Resources

/products
/products/{id}
/products/search

The interface

GET (a product)
PUT (a product)
DELETE (a product)

Discussion

Design a RESTful API for a web shop

- ☐ Browse products
- ☐ Search products
- ☐ Order products
- ☐ Track a customer's order history

Don't we need a service description?

- WSDL is a technical interface that lists methods
- WSDL is **NOT** service documentation
- XML Schema is still an option

Don't we need a service description?

- WSDL is a technical interface that lists methods
- WSDL is **NOT** service documentation
- XML Schema is still an option

We DO need service documentation

We DON'T need a technical interface description

We MIGHT need to provide XML schemas

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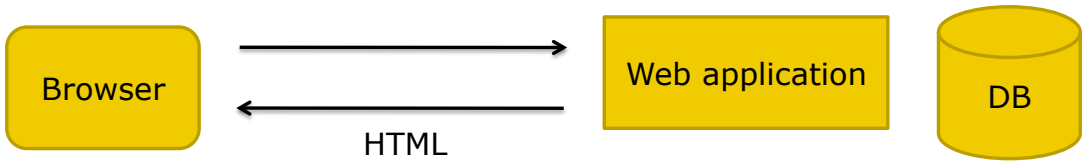
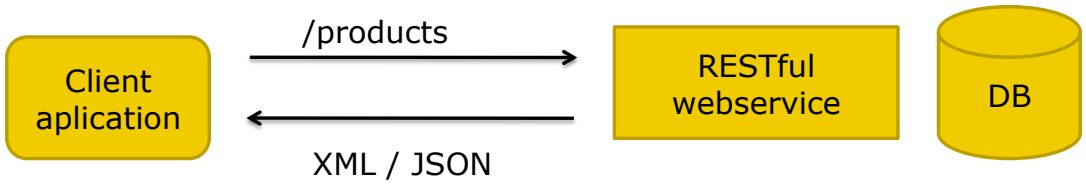
Implementing a web application



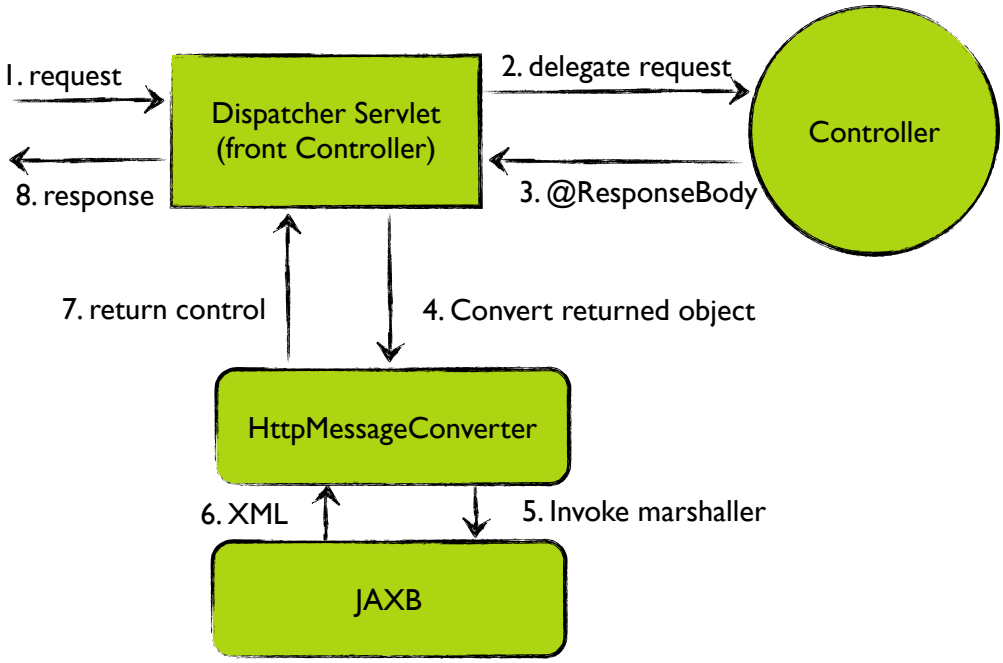
Implementing a web service



RESTful web services in Spring

- Web Services are implemented using controllers
- Familiar Spring MVC programming model

Handling web service requests



@ResponseBody

- The object returned is converted using a HttpMessageConverter
  - Jaxb2RootElementHttpMessageConverter
  - MappingJacksonHttpMessageConverter
  - StringHttpMessageConverter
  - etc.

```
@RequestMapping(method = RequestMethod.GET,
        value = "books",
        headers = "accept=application/xml")
public @ResponseBody BookList listBooksXml() {
    List<Book> books = bookCatalog.listBooks();
    return new BookList(books);
}
```

```
@XmlRootElement
public class Book {
```


Choosing handlers

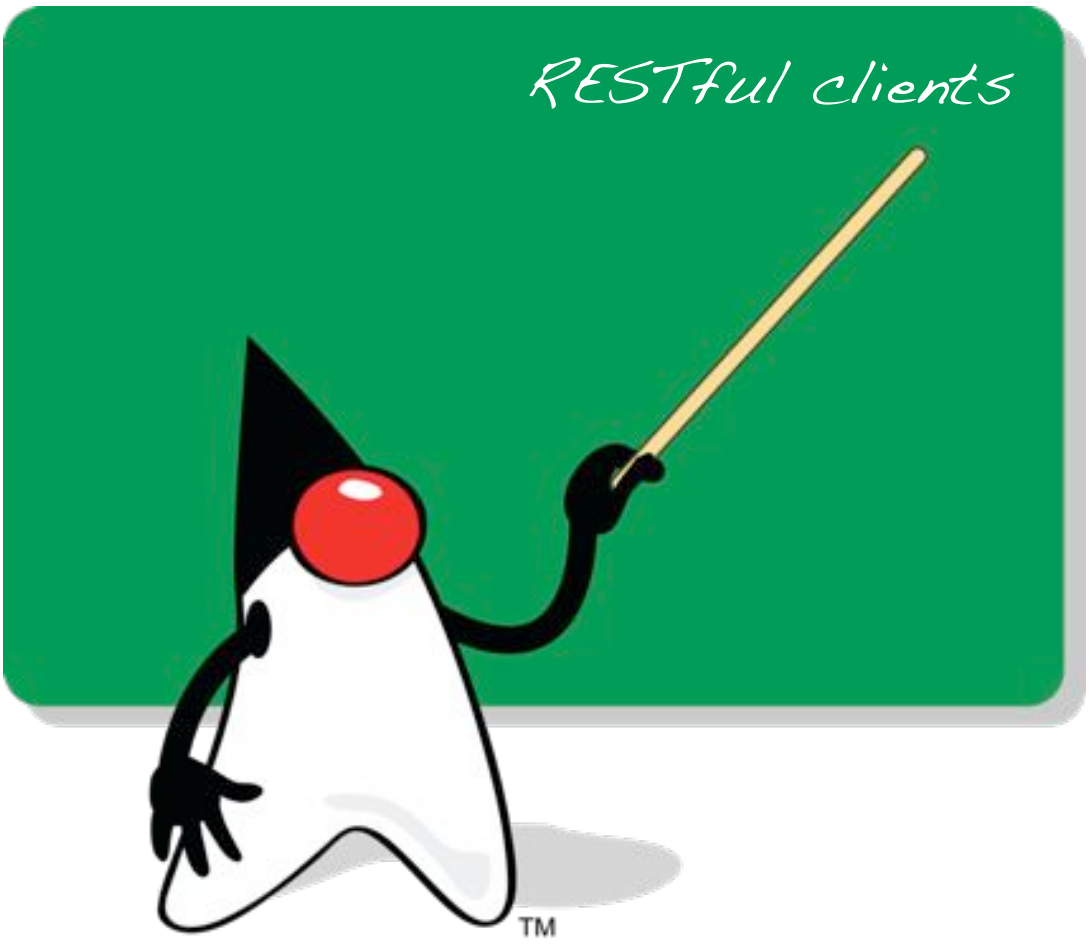
- How to offer data both as XML and HTML?
  - use the HTTP accept header
  - use a different extension
  - use a request parameter
  - use content negotiation

Choosing handlers

```
@RequestMapping(method = RequestMethod.GET,
        value = "books.xml")
```

```
@RequestMapping(method = RequestMethod.GET,
        value = "books",
        headers = "accept=application/xml")
```

```
@RequestMapping(method = RequestMethod.GET,
        value = "books",
        params = "contentType=application/xml")
```

RESTful clients

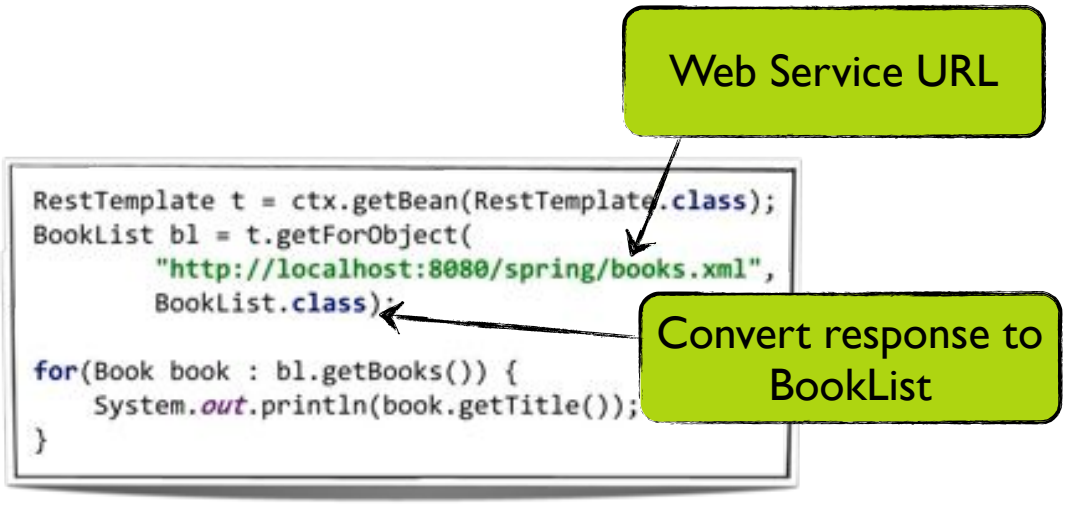
- Use RESTful web services using a template
- Configure template to convert messages

```
<bean id="restTemplate"
      class="org.springframework.web.client.RestTemplate">
    <property name="messageConverters">
        <array>
            <ref bean="bookConverter"/>
        </array>
    </property>
</bean>
```


Message converters

```
<bean id="bookConverter"
      class="...MarshallingHttpMessageConverter">
    <property name="marshaller" ref="marshaller"/>
    <property name="unmarshaller" ref="marshaller"/>
</bean>

<oxm:jaxb2-marshaller id="marshaller">
    <oxm:class-to-be-bound name="dvdstore.domain.Book"/>
    <oxm:class-to-be-bound name="dvdstore.domain.BookList"/>
</oxm:jaxb2-marshaller>
```

Calling a service



Putting data

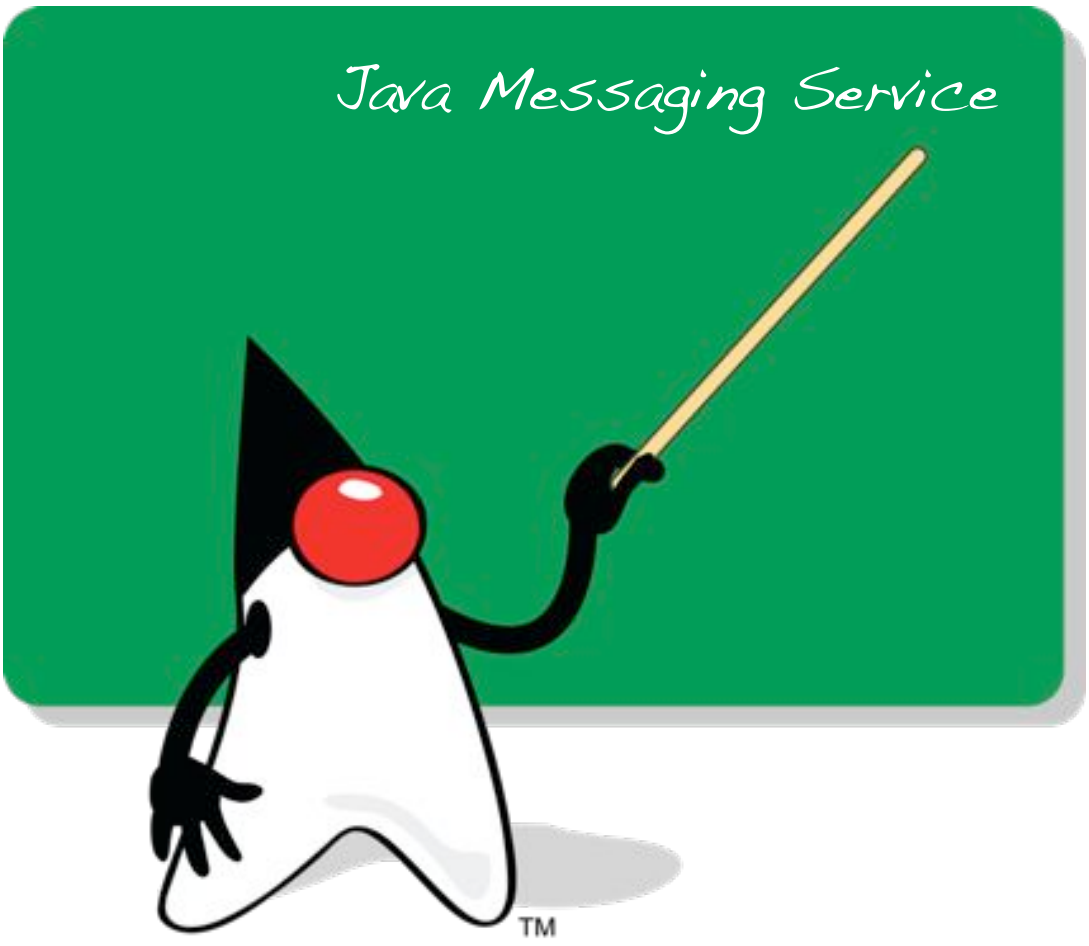
```
@RequestMapping(value = "books/{bookId}", method = RequestMethod.PUT)
public void updateBookFromXML(@PathVariable long bookId,
                              @RequestBody Book book,
                              HttpServletResponse response) {

    System.out.println("Saving book (" + bookId +"): " + book.getTitle());

    book.setId(bookId);
    bookCatalog.saveBook(book);
    response.setStatus(200);
}
```

```
RestTemplate t = ctx.getBean(RestTemplate.class);
final Book book = new Book();
book.setTitle("jQuery in Action");
t.put("http://localhost:8080/spring/books/1", book);
```

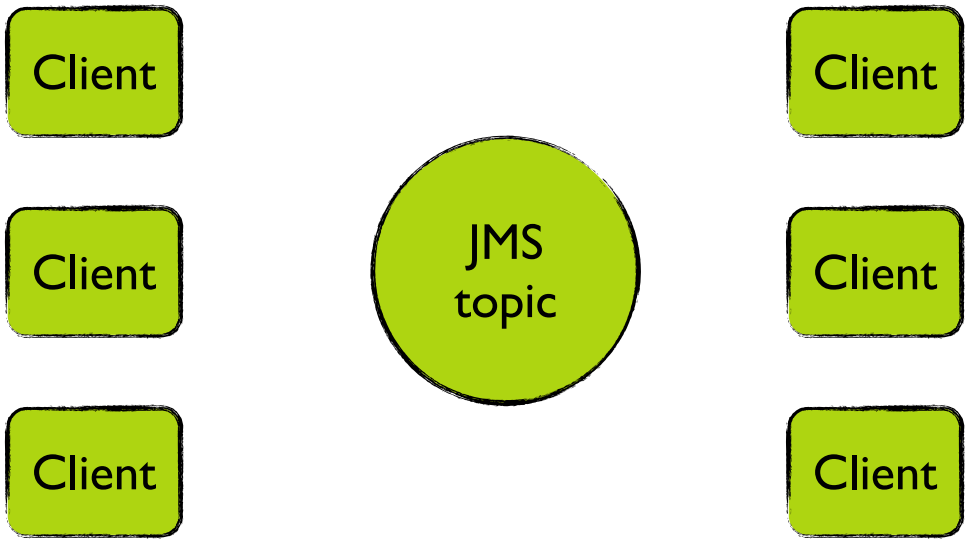
Posting data

```
@RequestMapping(method = RequestMethod.POST)
public
@ResponseBody
Book saveBook(@RequestBody Book bookXML) {
    System.out.println("Saving book" + bookXML.getTitle());
    Book book = bookCatalog.saveBook(bookXML);

    return book;
}
```

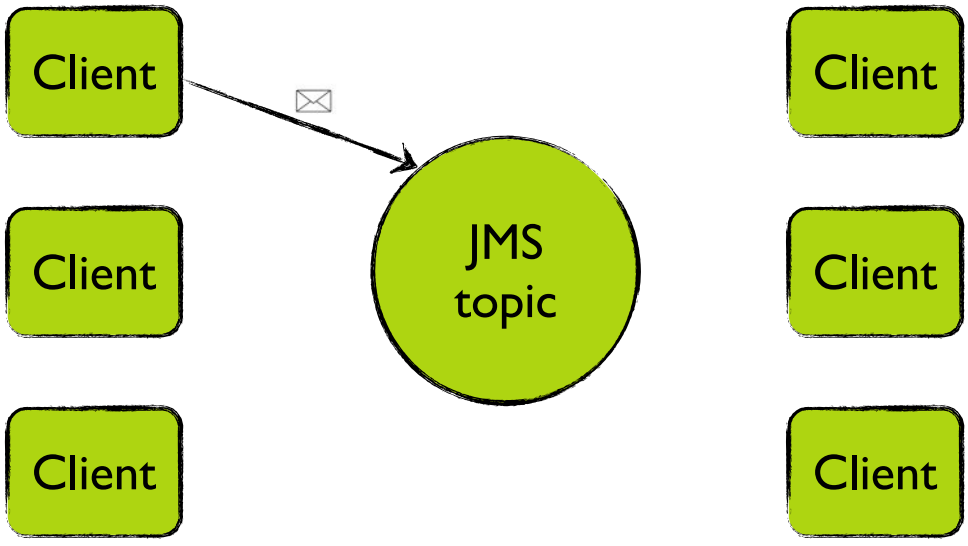
```
RestTemplate t = ctx.getBean(RestTemplate.class);
final Book book = new Book();
book.setTitle("jQuery in Action");
final URI newUrl = t.postForLocation(
        "http://localhost:8080/spring/books",
        book);
System.out.println("Book saved to: " + newUrl);
```

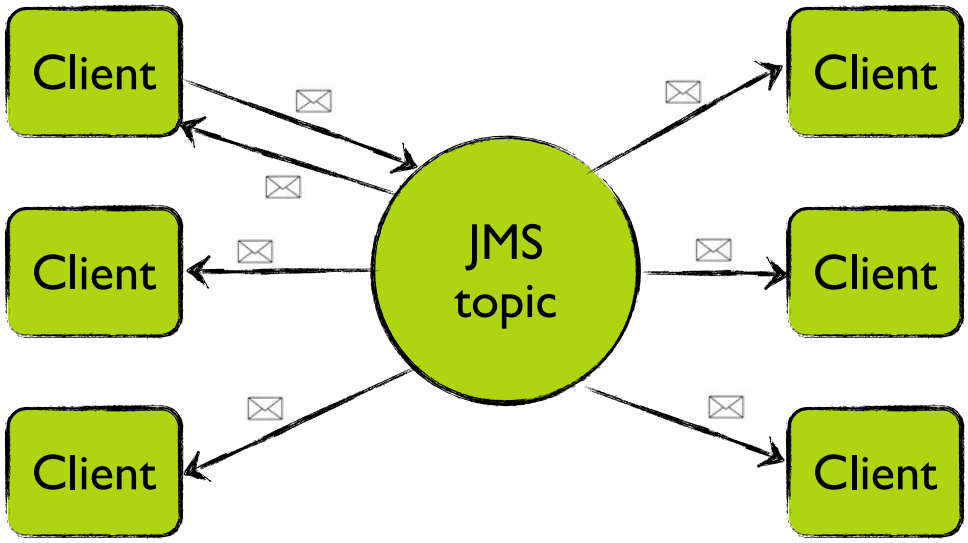
JMS Topics



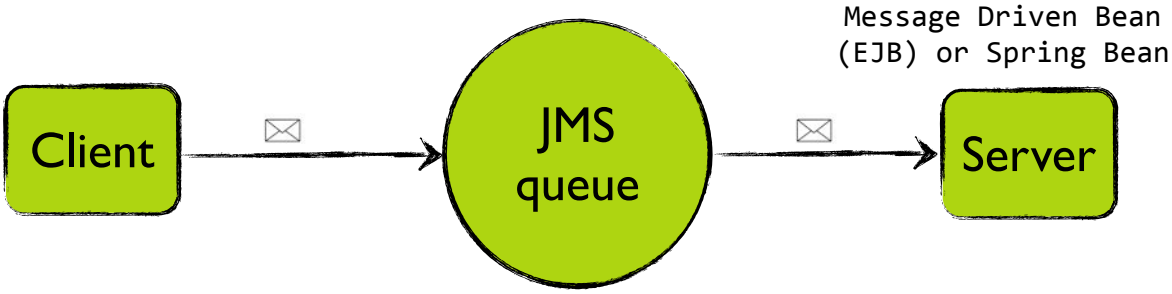
JMS Topics



JMS Topics

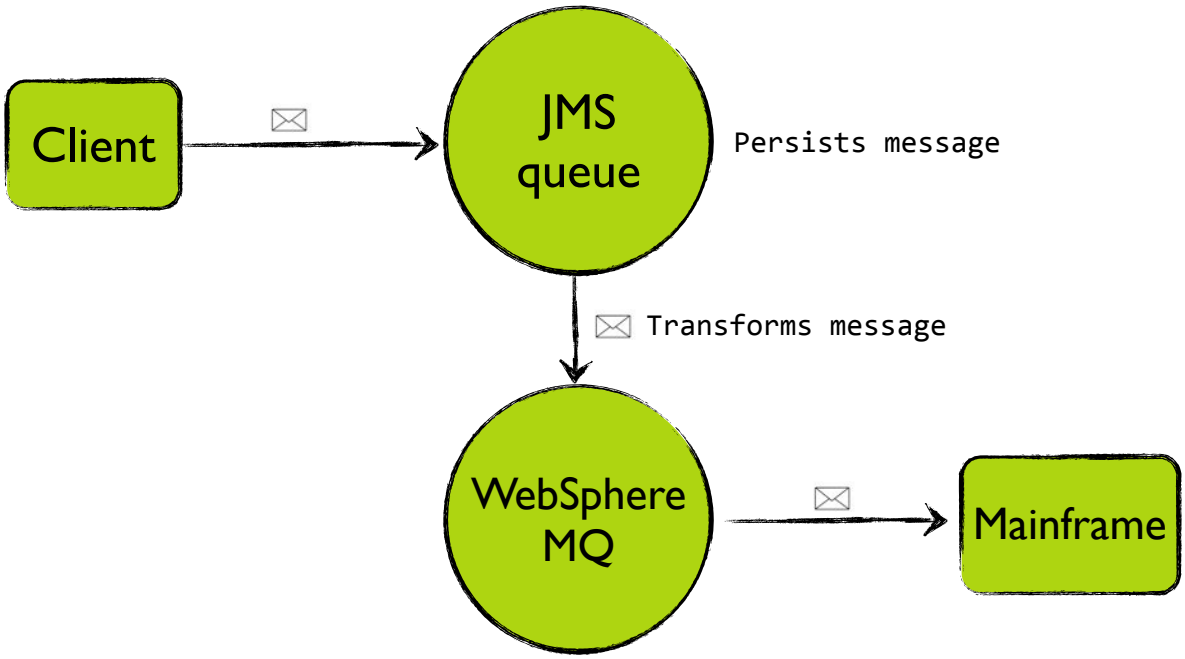


JMS Queues



Persists message

JMS Queues



Message Listener

```
@Component
public class BookJmsListener implements MessageListener{
    @Override
    public void onMessage(Message message) {
        if(message instanceof TextMessage) {
            TextMessage txt = (TextMessage)message;
            try {
                System.out.println("MSG: " + txt.getText());
            } catch (JMSException e) {
                e.printStackTrace();
            }
        } else {
            System.out.println("Received unknown message");
        }

    }
}
```

JMS connection factory

```
<bean id="connectionFactory"
      class="...PooledConnectionFactory"
      destroy-method="stop">
    <property name="connectionFactory">
        <bean class="org.apache.activemq.ActiveMQConnectionFactory">
            <property name="brokerURL">
                <value>tcp://localhost:61616</value>
            </property>
        </bean>
    </property>
</bean>
```

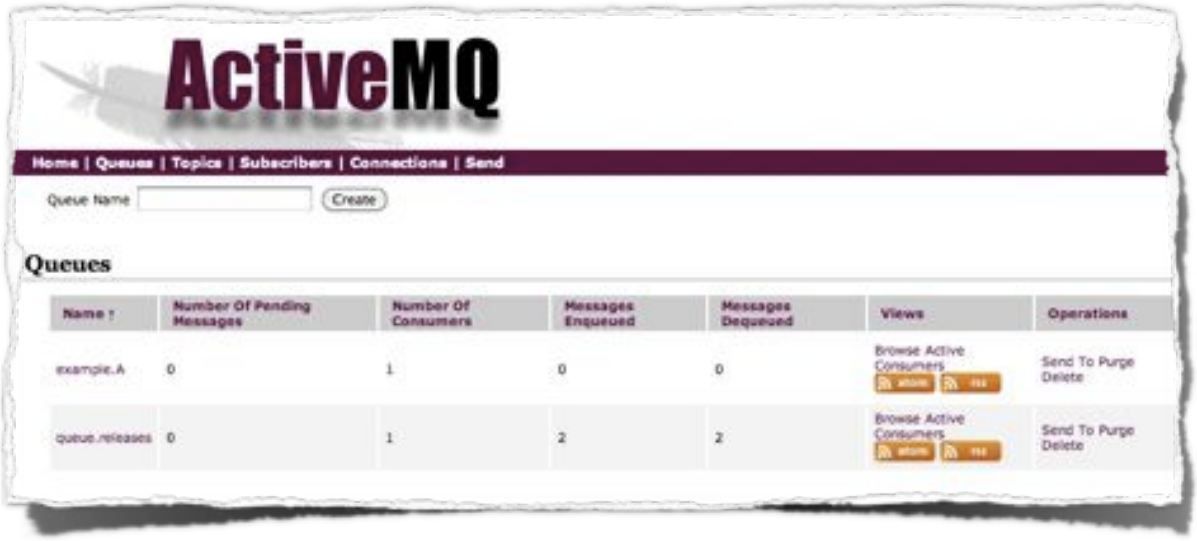

JMS listener

```
<jms:listener-container>
    <jms:listener destination="queue.releases"
                  ref="bookJmsListener"/>
</jms:listener-container>
```

Active MQ installation

- Start `bin/activemq.bat`
- Open `http://localhost:8161`
- Create new topic / queue

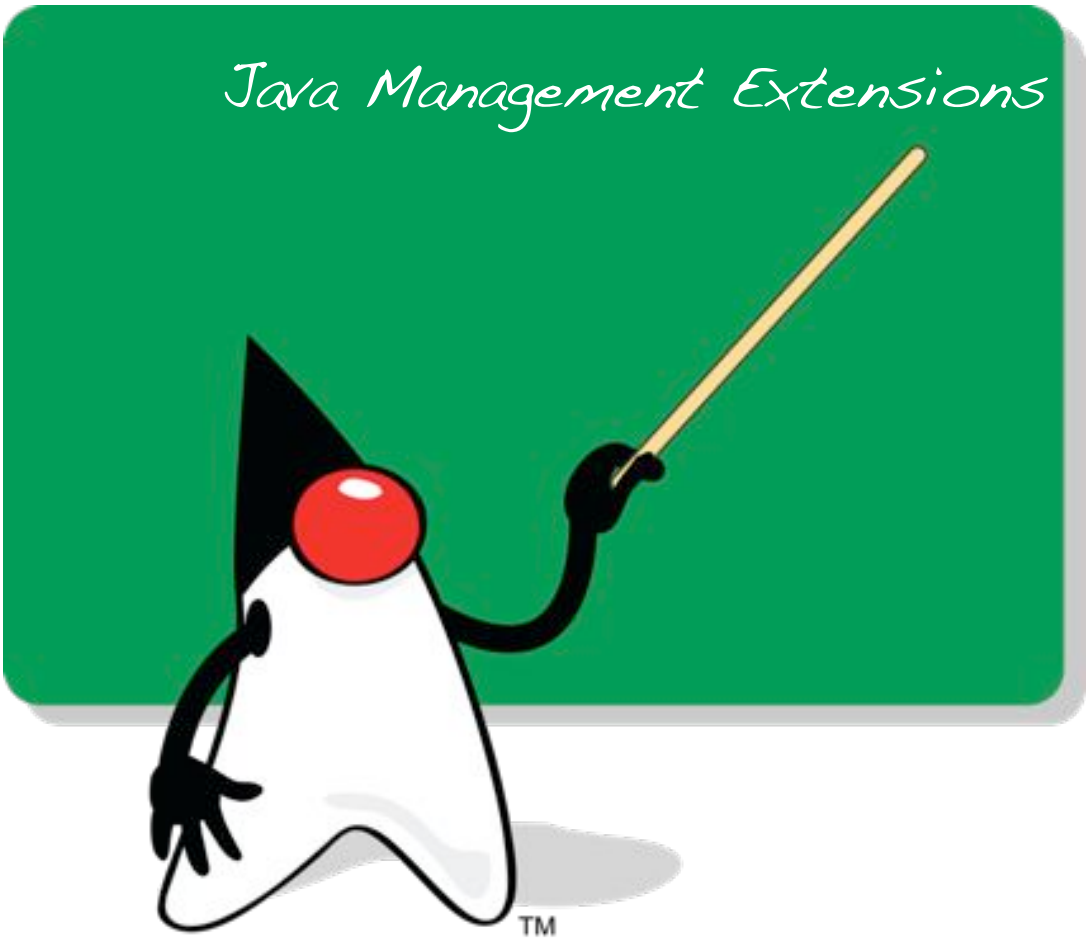
Active MQ installation



Sending test messages

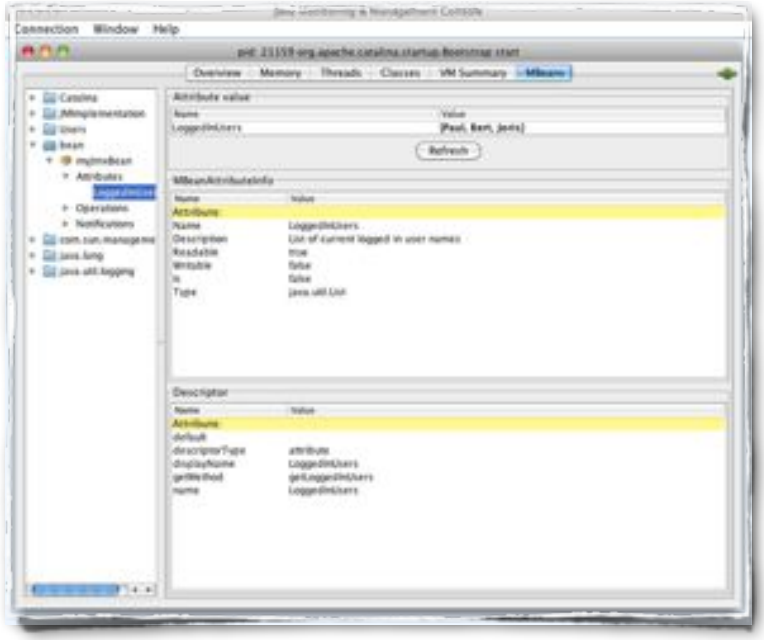
Sending messages

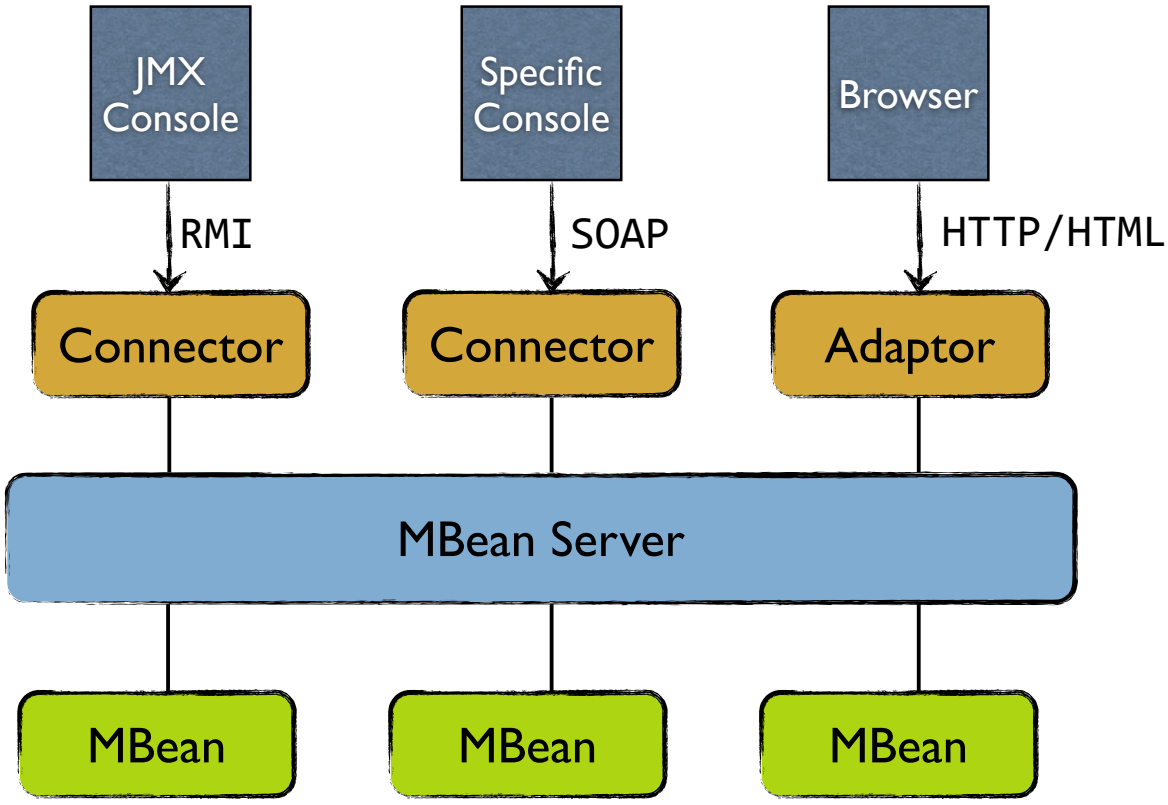
```
@Component
public class BookReleaseSender {
    private JmsTemplate jmsTemplate;

    @Autowired
    public void setConnectionFactory(ConnectionFactory cf) {
        this.jmsTemplate = new JmsTemplate(cf);
    }

    public void sendMessage(final Book book) {
        jmsTemplate.send("queue.releases", new MessageCreator() {
            @Override
            public Message createMessage(Session session) throws JMSException {
                return session.createTextMessage("New book: " + book.getTitle());
            }
        });
    }
}
```



JMX overview

- Manage and monitor Java applications using standard tools





Creating MBeans

Just a standard Spring bean

All public properties are exported

```
@Component("jmxBookManager")
public class JMXBookManager {
    @Autowired
    private BookCatalog bookCatalog;

    public int getNumberOfBooks() {
        return bookCatalog.listBooks().size();
    }

    public String[] getBookNames() {
        ...

        return books.toArray(new String[books.size()]);
    }
}
```

Exporting MBeans

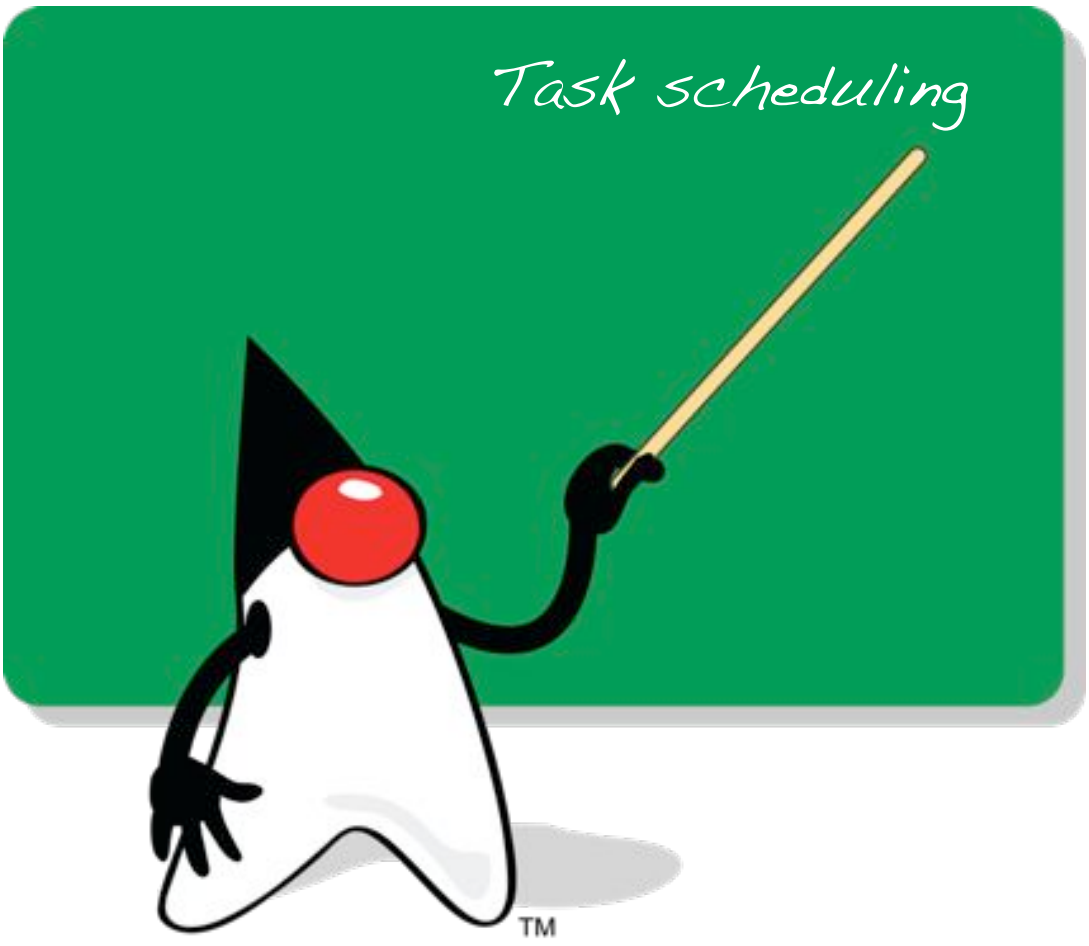
```
<bean id="exporter" class="...MBeanExporter" lazy-init="false">
    <property name="beans">
        <map>
            <entry key="bean:name=bookManager"
                   value-ref="jmxBookManager"/>
        </map>
    </property>
</bean>
```


Configuring what to export

```
@Component
@ManagedResource(objectName = "bean:name=myJmxBean",
        description = "My Managed Bean")
public class JMXExample {
    public String shouldNotBeExported() {
        return "not good";
    }

    @ManagedAttribute(description = "List of ...")
    public List<String> getLoggedInUsers() {
        return Arrays.asList("Paul", "Bert", "Joris");
    }
}
```

Using annotations to export

```
<bean id="exporter" class="...MBeanExporter">
    <property name="assembler" ref="assembler"/>
    <property name="namingStrategy" ref="namingStrategy"/>
    <property name="autodetect" value="true"/>
</bean>

<bean id="jmxAttributeSource"
      class="...AnnotationJmxAttributeSource"/>

<bean id="assembler"
      class="...MetadataMBeanInfoAssembler">
    <property name="attributeSource" ref="jmxAttributeSource"/>
</bean>

<bean id="namingStrategy"
      class="...MetadataNamingStrategy">
    <property name="attributeSource" ref="jmxAttributeSource"/>
</bean>
```

Scheduling tasks

```
<task:scheduler id="scheduler" pool-size="10"/>

<task:scheduled-tasks scheduler="scheduler">
    <task:scheduled ref="pingJob" method="ping"
                    cron="0 0/15 * * * *"/>
</task:scheduled-tasks>
```

```
@Component
public class PingJob {
    public void ping() {
        System.out.println("Ping!");
    }
}
```


Cron syntax

1. Seconds
2. Minutes
3. Hours
4. Day-of-Month
5. Month
6. Day-of-Week
7. Year (optional field)

`0 0 12 * * ?`	Fire at 12pm (noon) every day
`0 * 14 * * ?`	Fire every minute starting at 2pm and ending at 2:59pm, every day
`0 0-5 14 * * ?`	Fire every minute starting at 2pm and ending at 2:05pm, every day
`0 15 10 ? * MON-FRI`	Fire at 10:15am every Monday, Tuesday, Wednesday, Thursday and Friday
`0 0/5 14 * * ?`	Fire every 5 minutes starting at 2pm and ending at 2:55pm, every day

Annotation-driven tasks

```
<task:scheduler id="scheduler" pool-size="10"/>

<task:annotation-driven scheduler="scheduler"/>
```

```
@Component
public class AnnotationJob {

    //Schedule every 5 seconds
    @Scheduled(fixedDelay = 5000)
    public void doSomething() {
        System.out.println("I'm an annotated task");
    }
}
```