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Spring Framework

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About Me

- Maruthi R Janardhan
  - Been doing java since jdk 1.2
  - Been with IBM, ANZ, HCL-HP, my own startup Leviossa..
    - Newly launched a trivia/image sharing site flikbuk.com
  - Total 16 years programming C, C++, Java, Ruby, Perl, Python, PHP, etc

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UserManager v1

```
public class UserManager {

   private UserDao dao = new UserDao();

   public List<User> getAllUsers(){
      return dao.getAllUsers();
   }

}

public class UserDao {

   public List<User> getAllUsers(){
      //Do database queries here
      return new ArrayList<User>();
   }
}
```

UserManager v2

```
public class UserManager {

    private UserDao dao = new UserDaoImpl();

    public List<User> getAllUsers(){
        return dao.getAllUsers();
    }

}

public interface UserDao {

    public List<User> getAllUsers();
}

public class UserDaoImpl implements UserDao {
    public List<User> getAllUsers() {
        // Do database queries here
        return new ArrayList<User>();
    }
}
```

UserManager v3

```
public class UserManager {

   private UserDao dao = UserDaoFactory.getDao();

   public List<User> getAllUsers(){
      return dao.getAllUsers();
   }

}
public class UserDaoFactory {
   public static UserDao getDao(){
      return new UserDaoImpl();
   }
}

UserManager mgr = new UserManager();
List<User> users = mgr.getAllUsers();
```

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UserManager v4

```
public class UserManager {

   private UserDao dao;

   public UserDao getDao() {
      return dao;
   }
   public void setDao(UserDao dao) {
      this.dao = dao;
   }
   public List<User> getAllUsers() {
      return dao.getAllUsers();
   }
}

UserManager mgr = new UserManager();
mgr.setDao(new UserDaoImpl());
List<User> users = mgr.getAllUsers();
```

UserManager v5 (Spring)

```
<bean id="userManager" class="com.mydomain.biz.UserManager">
   <property name="dao" ref="userDao"></property>
</bean>
<bean id="userDao" class="com.mydomain.dao.UserDaoImpl">
</bean>

ApplicationContext context = new
ClassPathXmlApplicationContext(new String[] {"application-
context.xml"});
UserManager mgr = (UserManager)context.getBean("userManager");
List<User> users = mgr.getAllUsers();
```

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UserManager v6 & v7

Using static factory

```
<bean id="userManager" class="com.mydomain.biz.UserManager">
    <property name="dao" ref="userDao"></property>
</bean>
<bean id="userDao" class="com.mydomain.dao.UserDaoFactory" factory-
method="getDao">
</bean>
```

Using instance factory

```
<bean id="userDao" factory-bean="daoFactory" factory-method="getDao">
</bean>
<bean id="daoFactory" class="com.mydomain.dao.UserDaoFactory" factory-
method="getDao">
</bean>
```

UserManager v8

```
<bean id="userManager" class="com.mydomain.biz.UserManager">
   <constructor-arg ref="dao"></constructor-arg>
</bean>
<bean id="dao" class="com.mydomain.dao.UserDaoImpl">
</bean>
```

```
public class UserManager {
   private UserDao dao;

   public UserManager(UserDao dao) {
      this.dao = dao;
   }

   public List<User> getAllUsers() {
      return dao.getAllUsers();
   }
}
```

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UserManager v9

```
<bean id="userManager" class="com.mydomain.biz.UserManager">
   <property name="dao">
      <bean class="com.mydomain.dao.UserDaoImpl">
      </bean>
   </property>
</bean>
```

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UserManager v10

- Auto wiring byType and byName are possible

```
<bean id="userManager" class="com.mydomain.biz.UserManager"
autowire="byType" >
</bean>

<bean id="dao" class="com.mydomain.dao.UserDaoImpl" >
</bean>
```

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Creating With Values

```
<bean id="myDataSource" class="org.apache.commons.dbcp.BasicDataSource"
        destroy-method="close">
    <property name="driverClassName" value="com.mysql.jdbc.Driver"/>
    <property name="url" value="jdbc:mysql://localhost:3306/mydb"/>
</bean>
```

```
xmlns:p=“http://www.springframework.org/schema/p"

<bean id="myDataSource" class="org.apache.commons.dbcp.BasicDataSource"
destroy-method="close"
        p:driverClassName="com.mysql.jdbc.Driver"
        p:url="jdbc:mysql://localhost:3306/mydb"/>
```

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Values for Collections

```
<bean id="moreComplexObject" class="example.ComplexObject">
    <property name="adminEmails">
        <props>
            <prop key="administrator">administrator@example.org</prop>
            <prop key="support">support@example.org</prop>
        </props>
    </property>
    <property name="someList">
        <list>
            <value>a list element followed by a reference</value>
            <ref bean="myDataSource" />
        </list>
    </property>
    <property name="someMap">
        <map>
            <entry key="an entry" value="just some string"/>
            <entry key ="a ref" value-ref="myDataSource"/>
        </map>
    </property>
    <property name="someSet">
        <set>
            <ref bean=“someBean”/>
            <ref bean="myDataSource" />
        </set>
    </property>
</bean>
```

Creation Order

- Spring can see dependencies and create beans in the order needed. If for some reason the dependency is not visible through property references, we can use depends-on

- This also controls destruction order

```
<bean id="userManager" class="com.mydomain.biz.UserManager" depends-
on="myDataSource">
    <property name="dao">
        <bean class="com.mydomain.dao.UserDaoImpl">
        </bean>
    </property>
</bean>
```

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Lazy Initialisation & Singletons

- By default all beans are singleton and are created at container start.

- scope of prototype causes a new bean to be created with each getBean call

```
<beans default-lazy-init="true" >

<bean id="userManager" class="com.mydomain.biz.UserManager" lazy-
init="true" >

<bean id="userManager" class="com.mydomain.biz.UserManager"
scope="prototype" >
</bean>
```

Proxy

```
public class ProxyImpl implements java.lang.reflect.InvocationHandler {

    private Object obj;

    public static Object newInstance(Object obj) {
        return java.lang.reflect.Proxy.newProxyInstance(obj.getClass()
                .getClassLoader(), obj.getClass().getInterfaces(),
                    new ProxyImpl(obj));
    }

    private ProxyImpl(Object obj) {
        this.obj = obj;
    }

    public Object invoke(Object proxy, Method m, Object[] args) throws Throwable {
        Object result;
        try {
            //do something before
            result = m.invoke(obj, args);
            //do something after
        } catch (Exception e) {
            throw new RuntimeException("unexpected invocation exception: "
                    + e.getMessage());
        }
        return result;
    }
}
```

Lookup Methods

- When a singleton bean depends on a non-singleton bean, it can cause problems with threading

```
<bean id="userManager" class="com.mydomain.biz.UserManager" >
    <lookup-method name="createUserDao" bean="dao" />
</bean>

<bean id="dao" class="com.mydomain.dao.UserDaoImpl" scope="prototype">
</bean>

public abstract class UserManager {
    protected abstract UserDao createUserDao();

    public List<User> getAllUsers() {
        UserDao dao = createUserDao();
        System.out.println(this.getClass().getName());
        return dao.getAllUsers();
    }
}
```

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Bean Scopes

Scope	Description
singleton	(Default) Scopes a single bean definition to a single object instance per Spring IoC container.
prototype	Scopes a single bean definition to any number of object instances.
request	New bean for each request
session	New bean for each session
application	Bean valid for the application life cycle (Web)

BeanPostProcessors

- BeanPostProcessors act as extension points for the container. They are called for every bean that is instantiated in the container

```
public class MyBeanPostProcessor implements BeanPostProcessor {

    public Object postProcessBeforeInitialization(Object bean,
            String beanName) throws BeansException {
        return bean; // we could potentially return any object reference here...
    }

    public Object postProcessAfterInitialization(Object bean,
            String beanName) throws BeansException {
        System.out.println("Bean '" + beanName + "' created : " +
bean.toString());
        return bean;
    }

}
```

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Property Placeholder

```
<bean
class="org.springframework.beans.factory.config.PropertyPlaceholderConfi
gurer">
<property name="locations" value="classpath:com/foo/jdbc.properties"/>
</bean>

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

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Annotation Based

```
<context:component-scan base-package="com.mydomain.*" />
<context:annotation-config />

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Component;
@Component
public class UserManager {

   @Autowired
   private UserDao dao;

@Component
public class UserDaoImpl implements UserDao {

mgr = (UserManager)context.getBean(UserManager.class);
mgr = (UserManager)context.getBean("userManager");
```

Components That Are Scanned

- @Component – Indicates a auto scan component.
- @Repository – Indicates DAO component in the persistence layer.
- @Service – Indicates a Service component in the business layer.
- @Controller – Indicates a controller component in the presentation layer.

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Lets Try It

- Build an UserManager, UserManagerImpl, UserDao and UserDaoImpl backed with a real database and real method logic branching out of an UserManager class provided on share

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JSR 330 Annotations

```
@Named
public class UserDaoImpl implements UserDao {

import javax.inject.Inject;
import javax.inject.Named;

@Named
public class UserManager {

   @Inject
   private UserDao dao;
```

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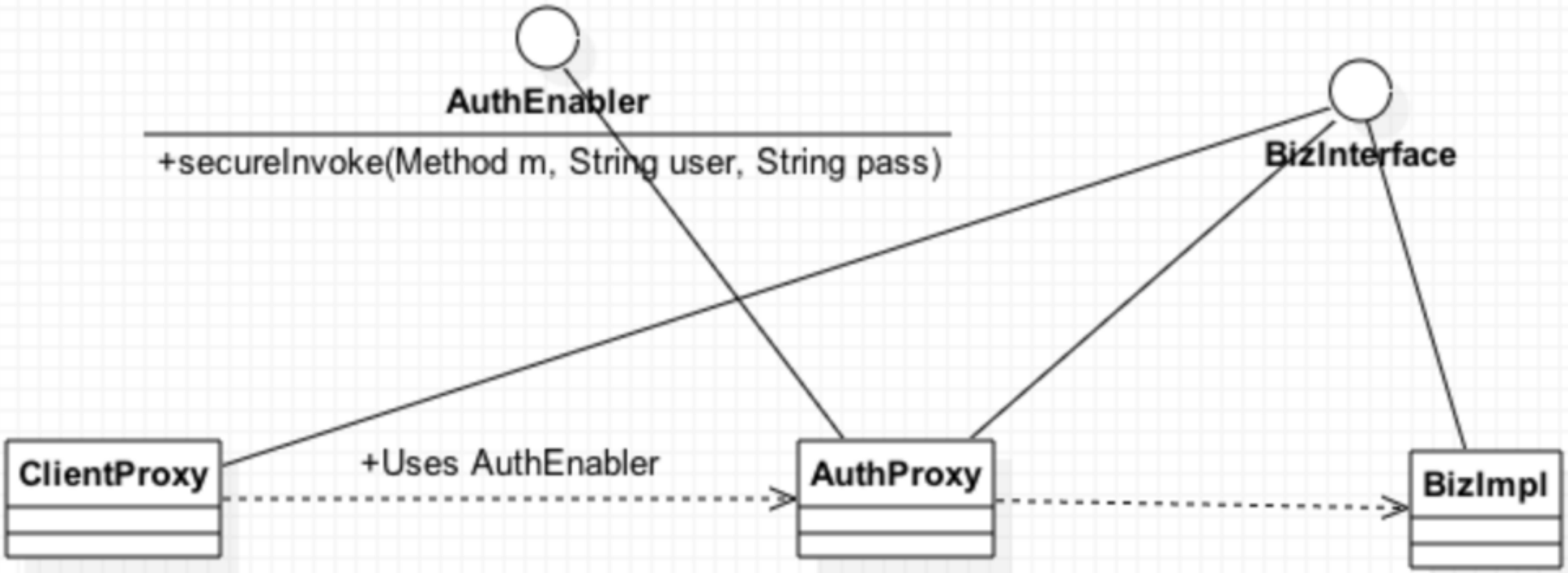
Implement a Proxy for Auth Checking



Steps

- AuthEnabler interface

```
public interface AuthEnabler {
   public Object secureInvoke(Method m, String user, String password,
Object... args);
}
```

- Create a dynamic proxy that can proxy any object plus implement AuthEnabler interface

```
List<Class> interfaces = new
ArrayList(Arrays.asList(obj.getClass().getInterfaces()));
interfaces.add(AuthEnabler.class);
Class[] classArr = interfaces.toArray(new Class[1]);
```

- Implement Proxy to check security

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Proxy Code

```
if(m.getName().equals("secureInvoke")){
   //Perform auth and call the target method
   Method targetMethod = (Method)args[0];
   String user = (String)args[1];
   String pass = (String)args[2];
   if(user.equals("admin") && pass.equals("admin123")){
      Object[] methodArgs = Arrays.copyOfRange(args, 3, args.length-1);
      return targetMethod.invoke(obj, methodArgs);
   }else{
      throw new Exception("Authentication info denied");
   }
}else{
   //Direct method invocation - prevent it
   throw new Exception("Authentication info not provided");
}
```

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We Need A Client Proxy

- newInstance checking

```
if(!(obj instanceof AuthEnabler)){
    throw new IllegalArgumentException("This class can only proxy Auth
Enabled classes");
}
```

- Proxy code

```
if(m.getName().equals("secureInvoke")){
    //This should never be called directly
    throw new IllegalStateException("Secure invoke should not be called on
the client proxy directly. Call the target method");
}else{
    //Grab auth info and call the secureInvoke method on the target
    String user = "admin";
    String pass = "admin123";
    return ((AuthEnabler)obj).secureInvoke(m, user, pass, args);
}
```

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Using Secure Factories

```
UserDaoImpl daoImpl = new UserDaoImpl();
UserDao secureDao = (UserDao)AuthProxyImpl.newInstance(daoImpl);

UserDao authEnabledClient =
(UserDao)ClientProxyImpl.newInstance(secureDao);
System.out.println(authEnabledClient.getAllUsers());
```

Create Factory Beans For Use in Spring

- Create proxy factories

```
public class AuthProxyFactory implements FactoryBean {
public class ClientProxyFactory implements FactoryBean {
```

- We need to support configuration like this:

```
<!-- Secure Bean Setup -->
<bean name="dao" class="com.mydomain.dao.UserDaoImpl"></bean>
<bean name="secureDao" class="com.mydomain.security.AuthProxyFactory">
    <property name="beanToSecure" ref="dao"></property>
</bean>

<bean id="authenticatedDao" name="authenticatedDao"
              class="com.mydomain.security.ClientProxyFactory">
    <property name="secureBean" ref="secureDao"></property>
</bean>
```

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Can we improve on this

- We need a way to proxy all beans that need security without having to declare a proxy for each one

- Answer is BeanPostProcessors

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Proxying with BeanPostProcessors

- Create an annotation for securing beans

```
@Retention(RetentionPolicy.RUNTIME)
public @interface Secure {

}
```

- Proxy all beans that have this annotation

```
public Object postProcessBeforeInitialization(Object bean, String
                                                        beanName)
        throws BeansException {
      if (bean.getClass().isAnnotationPresent(Secure.class)) {
        return AuthProxyImpl.newInstance(bean);
      } else {
        return bean;
      }
}
```

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Defining Post Processors

```
<bean name="dao" class="com.mydomain.dao.UserDaoImpl"></bean>
<bean class="com.mydomain.security.SecurityBeanPostProcessor"></bean>


    <bean id="authenticatedDao" name="authenticatedDao"
                  class="com.mydomain.security.ClientProxyFactory">
       <property name="secureBean" ref="dao"></property>
    </bean>
```

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We Still Need Proxy On Client

- Client Proxy Config

```
<bean id="authenticatedDao" name="authenticatedDao"
                        class="com.mydomain.security.ClientProxyFactory">
    <property name="secureBean" ref="dao"></property>
</bean>
```

- Use proxied instances for injection instead of autowiring

```
@Resource(name="authenticatedDao")
private UserDao dao;
```

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Spring AOP

- Provide declarative enterprise services, especially as a replacement for EJB declarative services.

- Allow users to implement custom aspects, complementing their use of OOP with AOP.

AOP Terminology

- Aspect: a modularisation of a concern that cuts across multiple classes.

- Join point: a point during the execution of a program, such as the execution of a method or the handling of an exception.

- Advice: action taken by an aspect at a particular join point.

- Pointcut: a predicate that matches join points.

Advice Types

- Before advice: Advice that executes before a join point, but which does not have the ability to prevent execution flow proceeding to the join point (unless it throws an exception).

- After returning advice: Advice to be executed after a join point completes normally

- After throwing advice: Advice to be executed if a method exits by throwing an exception.

- After (finally) advice: Advice to be executed regardless of the means by which a join point exits (normal or exceptional return).

- Around advice: Advice that surrounds a join point such as a method invocation.

Pointcut Designators

- execution - for matching method execution join points
- within - within certain types
- this - where the bean reference (Spring AOP proxy) is an instance of the given type
- target - where the target object is an instance of the given type
- args - where the arguments are instances of the given types
- @target - where the class of the executing object has an annotation of the given type
- @args - where the runtime type of the actual arguments passed have annotations of the given type(s)
- @within - within types that have the given annotation
- @annotation - limits matching to join points where the subject of the join point (method being executed in Spring AOP) has the given annotation
- bean - limits to named bean(s)

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Execution PCD format

- execution(modifiers-pattern? ret-type-pattern declaring-type-pattern? name-pattern(param-pattern) throws-pattern?)
  - Any public method: execution(public * *(..))
  - All setter methods: execution(* set*(..))
  - Methods of usermanager: execution(* com.mydomain.UserManager.*(..))
  - All methods in biz package: execution(* com.mydomain.biz.*.*(..))

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Steps to Create Aspects

- Annotate class with:

```
@Component
@Aspect
```

- Annotate method with one of the pointcuts:

```
@Pointcut("execution(* getAll*(..))")// the pointcut expression
public void getAllMethods() {}// the pointcut signature
```

- Declare the methods to use pointcuts

```
@Before("com.mydomain.aop.LoggingAspect.getAllMethods()")
```

- Invoke bean methods

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Advice Method Signatures

- Before:

```
@Before( value="com.domain.aop.LoggingAspect.getAllMethods()", argNames="joinPoint")
public void logMethodCallstart(JoinPoint joinPoint) {
```

- After:

```
@AfterReturning(returning="retVal",
value="com.mydomain.aop.LoggingAspect.getAllMethods()")
public void logMethodCallEnd(Object retVal) {
```

- AfterThrowing

```
@AfterThrowing(throwing="exception",value="com.mydomain.aop.LoggingAspect.getAllMethods
()")
public void logErrors(Throwable exception){
```

- Around

```
@Around("com.mydomain.aop.LoggingAspect.getAllMethods()")
public Object doBasicProfiling(ProceedingJoinPoint pjp) throws Throwable {
        Object retVal = pjp.proceed();
```

Passing Params To Advice

- Any advice method may declare as its first parameter, a parameter of type org.aspectj.lang.JoinPoint/ProceedingJoinPoint

- Using this joinpoint, everything can be found about the method that is being advised.

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Lets Try It

- Apply logging advice to methods of UserManager to find how long the methods takes to execute using an around advice

- Implement Transaction Management with AOP

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Custom Tx Manager

- We will need a tx manager class that acts as an around advice

```
@Component
@Aspect
public class CustomTxManager {
```

- This class needs to obtain connection and set it in thread local after starting the transaction on it

```
@Around("execution(public * com.mydomain.UserDao.*(..))")
    public Object startTransactions(ProceedingJoinPoint pjp) throws Throwable {
        Connection con = getConnection();
        con.setAutoCommit(false);
        Object result=null;
        try{
            threadLocalConnections.set(con);
            result = pjp.proceed();
            con.commit();
        }finally{
            threadLocalConnections.get().close();
        }
        return result;
    }
```

Custom Tx Manager

- UserDaoImpl needs to obtain the connection from this threadpool using a spring generated lookup method

```
public abstract class UserDaoImpl implements UserDao {

    public abstract Connection getCon();

    public List<User> getAllUsers() throws Exception{
        Statement statement = getCon().createStatement();
```

- Factory bean

```
public class CustomTxConnectionFactory implements FactoryBean<Connection>{

    public Connection getObject() throws Exception {
        return CustomTxManager.threadLocalConnections.get();
    }
```

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Custom Tx Manager

- Configuration in xml

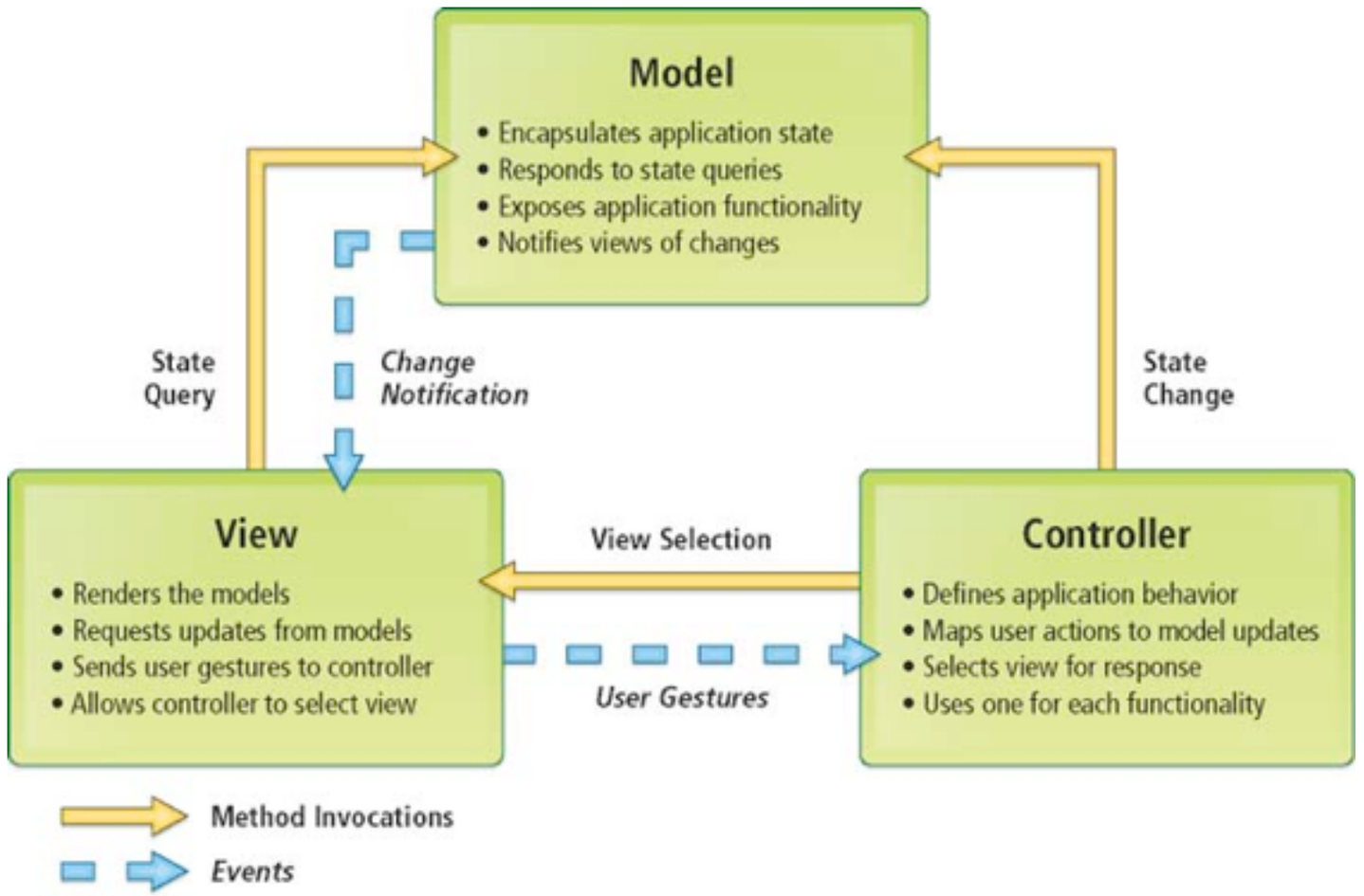
```
<bean name="dao" class="com.mydomain.dao.UserDaoImpl">
   <lookup-method name="getCon" bean="connection" />
</bean>


<bean name="connection"
class=“com.mydomain.aop.CustomTxConnectionFactory” scope="prototype"/>

<bean name="customTxMgr" class="com.mydomain.aop.CustomTxManager">
   <property name=“driverClass”><value>org.apache...</value></property>
   <property name=“connectionUrl”><value>jdbc:derby:…</value></property>
</bean>
```

Spring MVC

- The Spring web MVC framework provides model-view-controller architecture and ready components that can be used to develop flexible and loosely coupled web applications.



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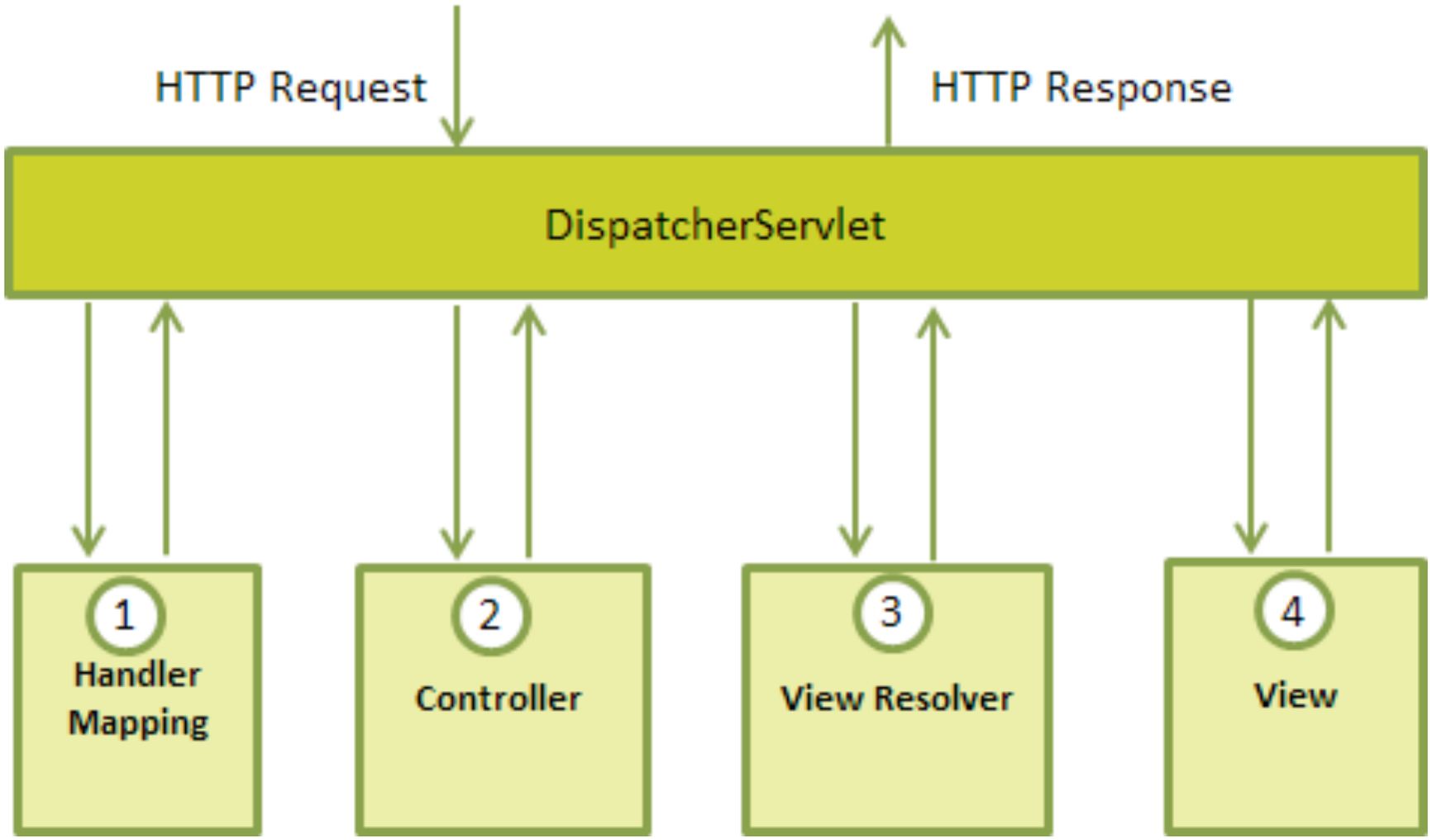
Spring MVC Flow



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Hello World

- Web.xml

```
<servlet>
     <servlet-name>action</servlet-name>
     <servlet-class>org.springframework.web.servlet.DispatcherServlet</servlet-class>
     <load-on-startup>1</load-on-startup>
</servlet>
<servlet-mapping>
     <servlet-name>action</servlet-name>
     <url-pattern>/action/*</url-pattern>
</servlet-mapping>
```

- WEB-INF/action-servlet.xml

```
<context:component-scan base-package="com.mydomain"/>
```

- Controller class

```
@Controller
public class HelloWorldController {

    @RequestMapping("/helloWorld")
    public String helloWorld(Model model) {
        model.addAttribute("message", "Hello World!");
        return "/helloWorld";
    }
}
```

- helloWorld.jsp - put this in WEB-INF\Views folder (this folder needs to be created)

```
<%@ page isELIgnored="false"%>
<h2>${message}</h2>
```

Passing Form Data

- Declare controller that accepts form data as a bean

```
@Controller
public class UserController {

    @Autowired
    UserManager userManager;

    @RequestMapping("/addUser")
    public String addUser(User u, Model model) throws Exception {
      userManager.addUser(u);
        model.addAttribute("message", "Added User!");
        return "/helloWorld.jsp";
    }
}
```

- Submit form to this servlet

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Validating Forms

- Implement Validators

```
public class UserValidator implements Validator{

public void validate(Object obj, Errors err) {
        ValidationUtils.rejectIfEmptyOrWhitespace(err, "name", "field.required", "Field Name is
required”);
...
```

- Change controller for validation handling

```
  @RequestMapping("/addUser")
    public String addUser(@Valid User u, BindingResult bindingResult, Model model) throws Exception {
    if (bindingResult.hasErrors()) {
            return "UserForm";
        }…
@InitBinder
    protected void initBinder(WebDataBinder binder) {
        binder.setValidator(new UserValidator());
    }
```

- Change Form to display validation errors

```
<%@ taglib uri="http://www.springframework.org/tags/form" prefix="springForm"%>
<springForm:errors path="user.age" cssClass="error" /><br>
```

Model Attributes

- @ModelAttribute annotation on a method causes the method to be executed and its return value placed on a model whenever the controller is fired

- @ModelAttribute annotation on a method argument indicates the argument should be retrieved from the model. If not present in the model, the argument should be instantiated first and then added to the model.

    - Once present in the model, the argument's fields should be populated from all request parameters that have matching names.

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Populate Age List

- Create a model attribute method to return list of age values

```
@ModelAttribute("ageList")
public List<Integer> getAgeList(){
    Integer[] ages = new Integer[]{18,19,20,21,22,23,24,25,26,27,28,29,30};
    return Arrays.asList(ages);
}
```

- Use it on JSP using jstl

```
<select name="age">
    <c:forEach items="${ageList}" var="ageVal">
        <option value="${ageVal}">${ageVal}</option>
    </c:forEach>
</select>
```

- Change it over to use Spring tags

```
@ModelAttribute("user")
    public User getUser(){
        return new User();
    }
<springForm:select path="user.age" items="${ageList}" ></springForm:select>
```

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URI Templates

- URI templates can be used for convenient access to selected parts of a URL in a @RequestMapping method.

```
@RequestMapping("/delete/{userId}")
public String delete(@PathVariable int userId) throws Exception{
```

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Returning Data From Controller

- @ResponseBody annotation delivers the return value of the controller directly

- RequestMapping annotation needs to identify the return data content type properly

```
@RequestMapping(value="/listUsersJson", produces =
MediaType.APPLICATION_JSON_VALUE)
```

Create Users List - JSON

- Create Controller Method to get List of users

```
public String listUsersJson() throws Exception{
     List<User> users = userManager.getAllUsers();
```

- Annotate it to allow direct data return and identify the response data to be json

```
@RequestMapping(value="/listUsersJson", produces = MediaType.APPLICATION_JSON_VALUE)
@ResponseBody
```

- Convert the users list to json and return

```
String usersJson = JSONObject.valueToString(users);
```

- Write AJAX code to load this list

```
<script type="text/javascript" src="../scripts/jquery-2.1.3.js"></script>
<script>
function loadUsers(){
     $.ajax(  {
          url: 'listUsersJson',
          method: 'get',
          headers: { 'Accept': 'application/json' },
          success: function(data) {
               $("#userTable").html("");
               for(var index in data){
                    var row = "<tr><td>"+data[index].name+"</td><td>"+data[index].age+"</td></tr>";
                    $("#userTable").append(row);
               }
          }
     });
}
$(document).ready(function(){
     loadUsers();
});
</script>
```

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Remoting With Spring

- RMI
  - not possible to access the objects through the HTTP protocol
  - RMI is a fairly heavy-weight protocol
  - Important when using a complex data model that needs serialisation over the wire.
  - RMI-JRMP is tied to Java clients: It is a Java-to-Java remoting solution.

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Remoting With Spring

- Spring's HTTP invoker
- HTTP-based remoting but also rely on Java serialization.
- It shares the basic infrastructure with RMI invokers, just using HTTP as transport.

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Remoting With Spring

- JAX-WS
  - Standard WebServices using SOAP
  - Works with an compliant WebServices client
  - Complex datatypes can be hard to map and serialise to XML structures

RMI Remoting

- Create Remote interface extending “Remote”
- Implement the interface in the business class
- Export it using a bean definition like this:

```
<bean class="org.springframework.remoting.rmi.RmiServiceExporter">
        <!-- does not necessarily have to be the same name as the bean to be
exported -->
        <property name="serviceName" value="UserManager"/>
        <property name="service" ref="userManager"/>
        <property name="serviceInterface"
                            value="com.mydomain.service.UserManagerRemote"/>
        <!-- defaults to 1099 -->
        <property name="registryPort" value="1199"/>
        <property name="alwaysCreateRegistry" value="true"/>
    </bean>
```

RMI Client

```
String name = "UserManager";
Registry registry = LocateRegistry.getRegistry("localhost",1199);
UserManagerRemote um = (UserManagerRemote) registry.lookup(name);
List<User> users = um.getAllUsers();
```

OR Inject like this:

```
<bean id="userManagerRemote"
class="org.springframework.remoting.rmi.RmiProxyFactoryBean">
    <property name="serviceUrl" value="rmi://localhost:1199/
UserManager"/>
    <property name="serviceInterface"
value="com.mydomain.service.UserManagerRemote"/>
</bean>
```