LESSON 2

INSIDE JAVA MVC WEB FRAMEWORKS

Appreciating All Levels From Surface to Depth

MVC Origins Pre-Date the Web

- ***Probably the widest quoted pattern in UI development is Model View Controller (MVC) - it's also the most misquoted***.

  - Martin Fowler

- MVC was created long before the first web application

  Xerox Parc late 70's

- Use case: Rich client ***Desktop*** Graphical User Interfaces
- Fundamental concept - use of the ***Observer*** pattern:

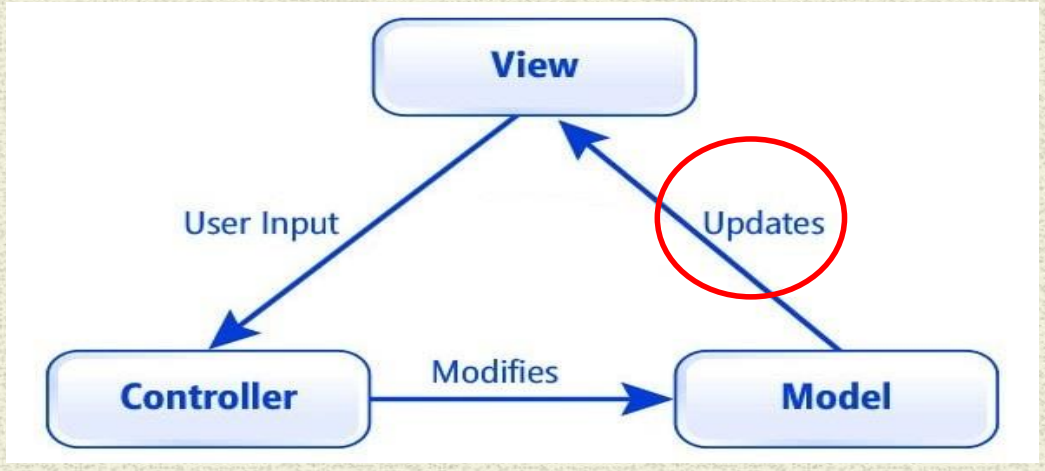
  views and controllers can react to model changes

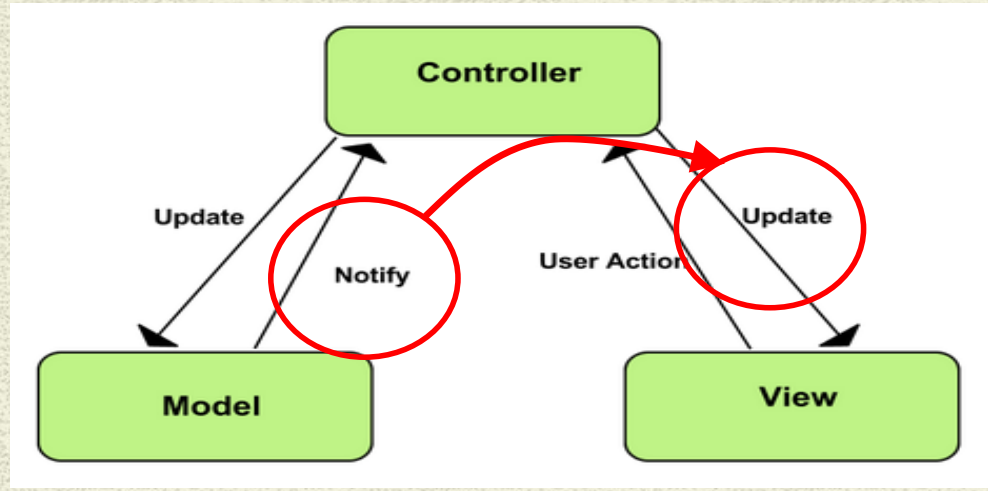
  Possible on single machine – no network involved

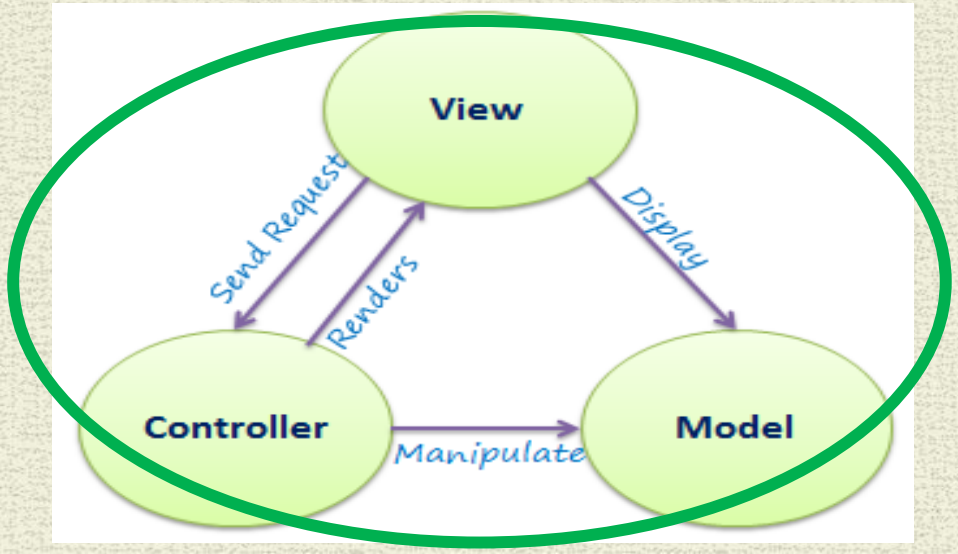
  On the Web

  Request/response nature of HTTP effectively disables the use of the Observer pattern

“Generic” MVC Diagrams







MV* Frameworks

MVC is a fundamental web framework pattern

It has been modified to fit various use cases.

These are variations:

MVP – Model View Presenter

MVVM – Model View View-Model

AND

MVW – Mode View Whatever

What is most important is ***SEPARATION OF CONCERNS***

MV* Frameworks

Web MVC Framework Types

Push Type

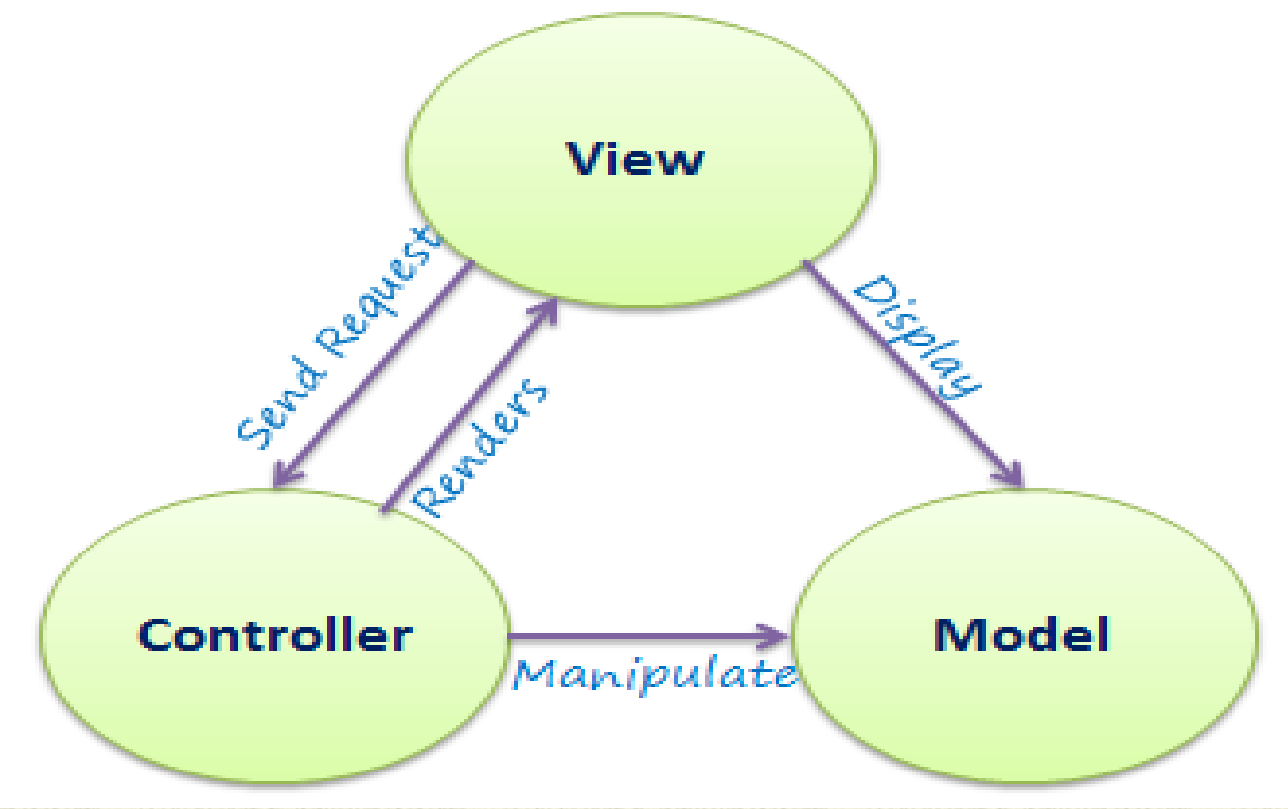
- User actions interpreted by the Controller
- Subsequently the data[Model] is pushed on to the View

  [***during rendering phase***]
- Suited for action – task architectures [e.g. Spring MVC]

Pull Type

- User requires specific output (like a list items from the database). The View accesses the Controller in a specific way to get the data it needs or “pulls” from data Model [***during rendering phase***]
- Suited for rich UI, component type architectures [e.g., Java Server Faces]

Course Reference: "generic" ***Web*** MVC Diagram



What is a [MVC] Web Framework?

Designed to simplify development

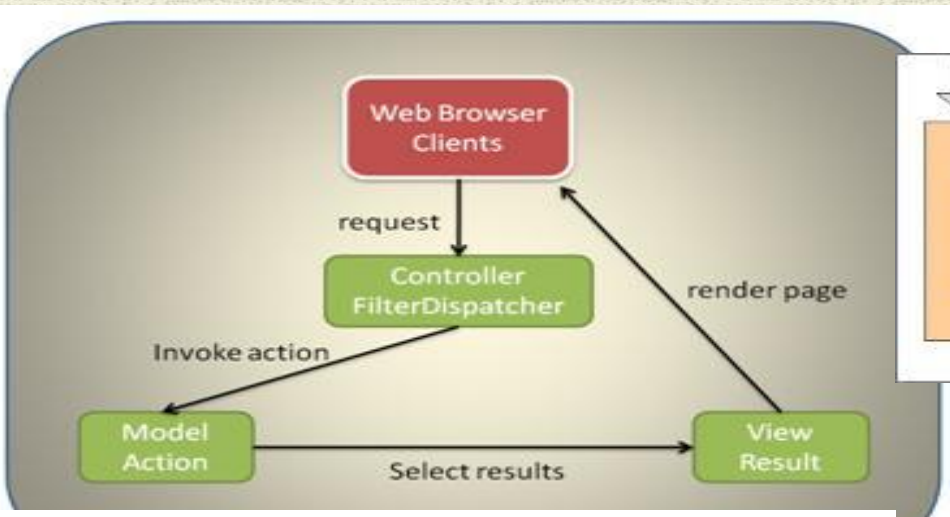
- Has already been built, tested, and industry hardened
- Increases reliability and reduces programming time
- Adheres to DRY principle
- Helps enforce best practices and rules

Common Features

- ***MVC Front Controller Pattern***
- ***Validation Framework***
- ***Declarative Routing***
- ***Data Binding***
- Session Management
- Security
- Data Persistence

- NOTE: All Frameworks have: Learning Curves”

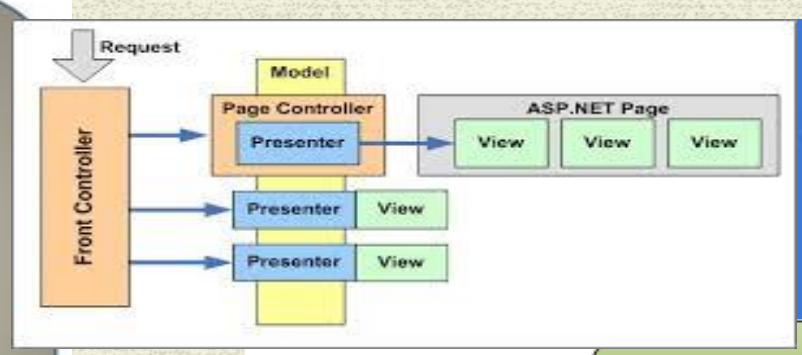
FRONT CONTROLLER

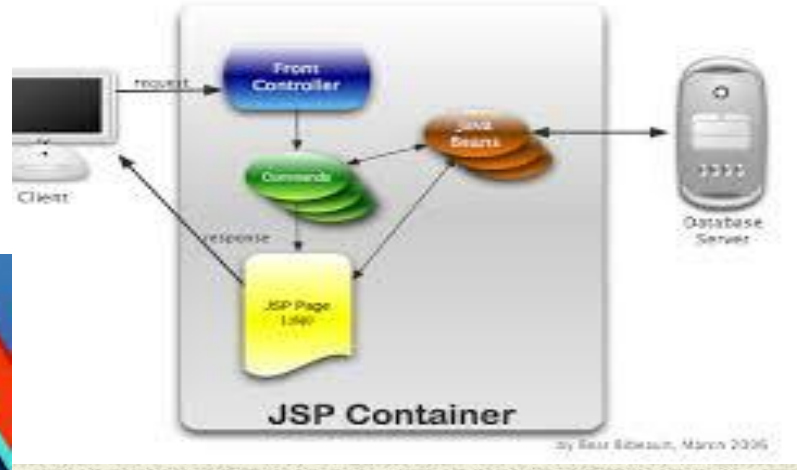


Front Controller

Problema

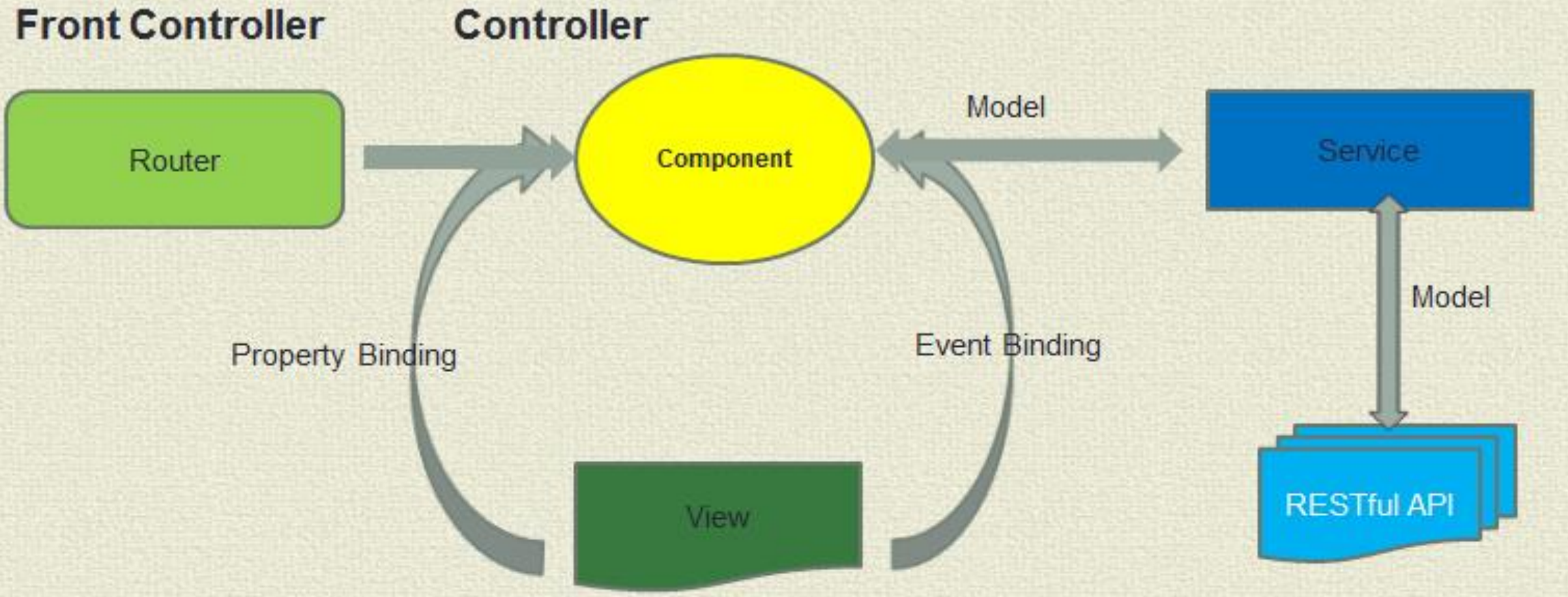
- Si vuole fornire un punto di accesso centralizzato per la gestione delle richieste al livello dello strato di presentazione, in modo da sparare la logica di presentazione da quella di *processamento* delle richieste stesse.
- Inoltre si vuole evitare di avere del codice duplicato e si vuole applicare una logica comune a più richieste.



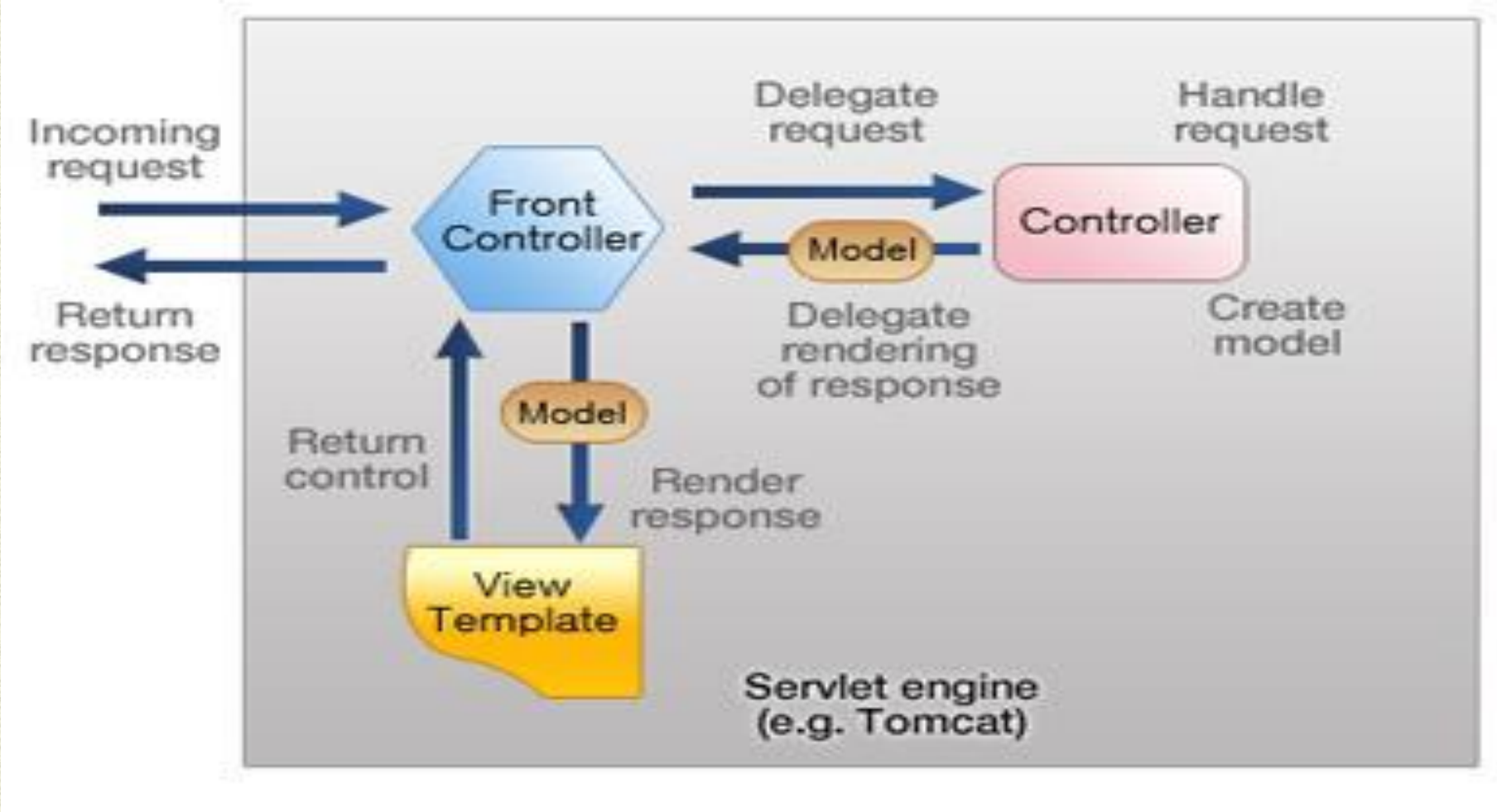


Front Controller Examples

Angular 2+



Spring MVC Front Controller



DEMO Time - Let's take a Look ***inside***!

PHASE I - Front Controller & Validation

web.xml:

```
<servlet>
    <servlet-name>DispatcherServlet</servlet-name>
    <servlet-class>mum.edu.servlet.DispatcherServlet</servlet-class>
</servlet>
<servlet-mapping>
    <servlet-name>DispatcherServlet</servlet-name>
     <url-pattern>/</url-pattern>
</servlet-mapping>
```

DispatcherServlet

```
public class DispatcherServlet extends HttpServlet {
    @Override
    public void doGet(...) {
        process(request, response);
    }
    @Override
    public void doPost(...) {
        process(request, response);
    }
    private void process(...) {
        if (action.equals("/product_input") || action.equals("/")) {
        InputProductController controller = new InputProductController();
        dispatchUrl = controller.handleRequest(request, response);
        } else if (action.equals("/product_save")) {
        SaveProductController controller = new SaveProductController();
        dispatchUrl = controller.handleRequest(request, response);
        }
        if (dispatchUrl != null) {
            RequestDispatcher requestDispatcher =
                    request.getRequestDispatcher(dispatchUrl);
            requestDispatcher.forward(request, response);
        }
    }
```

SaveProductController

```
public String handleRequest(...) {
        ProductForm productForm = new ProductForm();
        productForm.setName(request.getParameter("name"));
        productForm.setDescription(request.getParameter("description"));
        productForm.setPrice(request.getParameter("price"));
        // validate ProductForm
        ProductValidator productValidator = new ProductValidator();
        List<String> errors = productValidator.validate(productForm);
        if (errors.isEmpty()) {
            Product product = new Product();
            product.setName(productForm.getName());
            product.setDescription(productForm.getDescription());
            product.setPrice(Float.parseFloat(productForm.getPrice()));
            request.setAttribute("product", product);
            return "/WEB-INF/jsp/ProductDetails.jsp";
        } else {
            request.setAttribute("errors", errors);

            request.setAttribute("form", productForm);
            return "/WEB-INF/jsp/ProductForm.jsp";
        }
```

X

ProductValidator

```
public class ProductValidator {

public List<String> validate(ProductForm productForm) {
List<String> errors = new ArrayList<String>();
String name = productForm.getName();
if (name == null || name.trim().isEmpty()) {
errors.add("Product must have a name");
}
String price = productForm.getPrice();
if (price == null || price.trim().isEmpty()) {
errors.add("Product must have a price");
} else {
try {
Float.parseFloat(price);
} catch (NumberFormatException e) {
errors.add("Invalid price value");
}
return errors;
```

PHASE II - Declarative Routing

Generalize the URL-to-Controller Mapping.

Access a config file through WEB.XML declaration

web.xml:

```
<servlet-name>DispatcherServlet</servlet-name>
<servlet-class>mum.edu.servlet.DispatcherServlet</servlet-class>
  <init-param>
    <param-name>configFile</param-name>
    <param-value> config.properties </param-value>
  </init-param>
```

Load & instantiate Controllers at Startup

PHASE II - Declarative Routing [cont.]

Config File data:

```
/product_input=mum.edu.controller.InputProductController
/product_save=mum.edu.controller.SaveProductController
/=mum.edu.controller.InputProductController
```

```
public class DispatcherServlet extends HttpServlet {
     Map controllerDispatch = null;

   @Override
    public void init( ) throws ServletException {

    LoadServletProperties  loadServletProperties=
                                    new LoadServletProperties();
    controllerDispatch = loadServletProperties.loadControllers();
    }
```

Dispatcher Routing Change

```
if (action.equals("/product_input") || action.equals("/")) {
  InputProductController controller =
                            new InputProductController();
   dispatchUrl = controller.handleRequest(request, response);
} else if (action.equals("/product_save")) {
  SaveProductController controller =
                            new SaveProductController();
  dispatchUrl = controller.handleRequest(request, response);
}
```

REDUCES TO THIS:

```
  Controller controller = (Controller) controllerDispatch.get(action);
dispatchUrl = controller.handleRequest(request, response);
```

Main Point

Frameworks make Web development easier and more effective by providing a secure and reliable foundation on which to build upon.

In like manner, the simplest form of awareness, Transcendental Consciousness, provides a strong foundation for building success.

There is MORE that we can do !!!

WE can:

- Have MULTIPLE URIs route to a SINGLE Controller
- AUTOMATICALLY BIND the Domain Object to JSP form

AND Eventually:

- Implement Dependency Injection
- Employ Annotations

But FIRST:

Java Frameworks & Reflection API

Reflection is a fundamental aspect of Java frameworks

Reflection allows frameworks to deal with any class at runtime without prior knowledge of it[class].

The Reflection API provides the following functions:

- Examine an object's class at runtime
- Construct an object for a class at runtime
- Examine a class's field and method at runtime
- Invoke any method of an object at runtime

NOTE: Reflection can have a Performance cost

Java “meta-Class”

All objects are instances of a class, and all classes are objects.

Class java.lang. Object

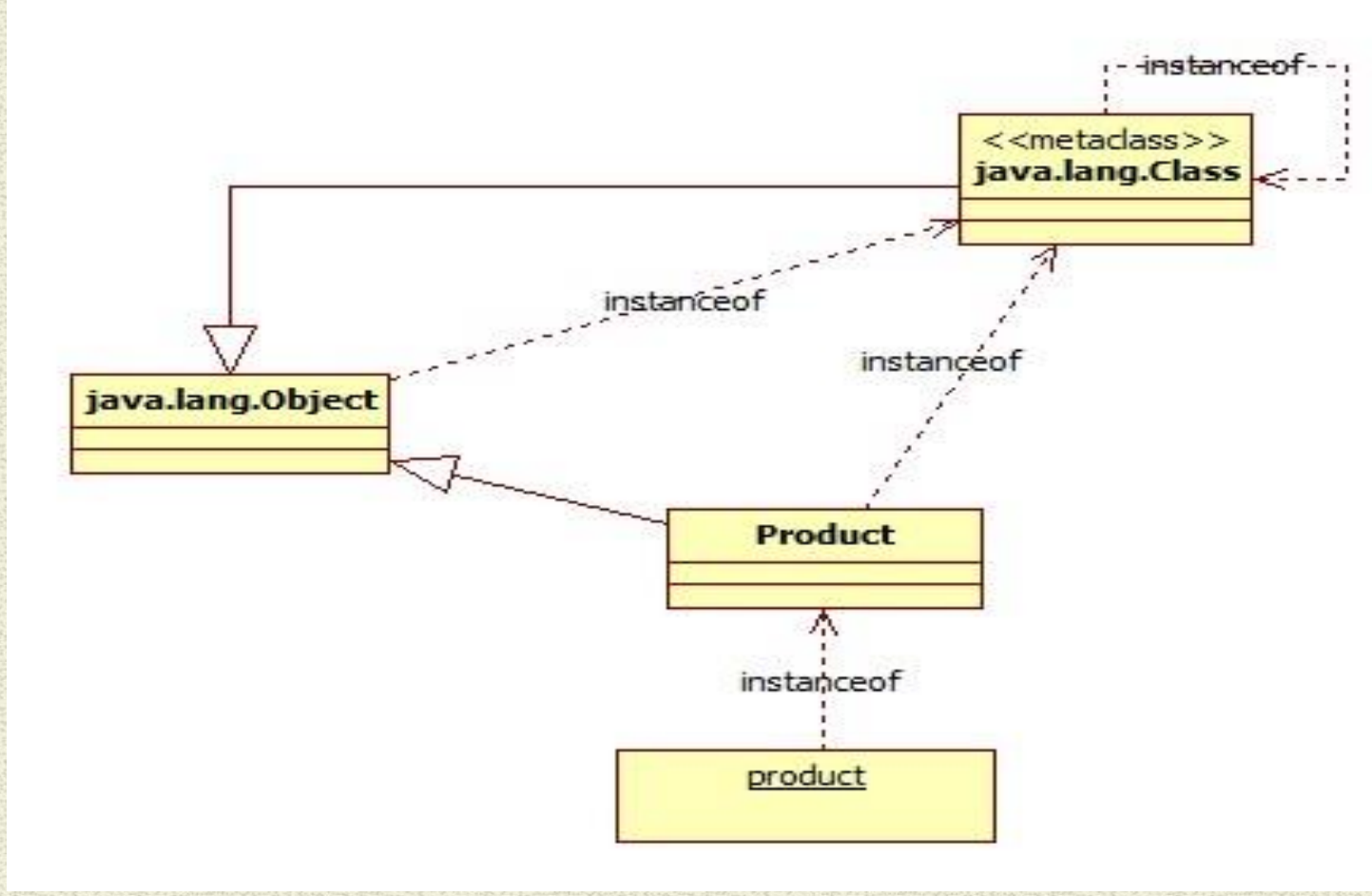
public class **Object**

Class Object is the root of the class hierarchy. Every class has Object as a superclass.

Class java.lang. Class

final class **Class** extends **Object;**

Instances of Class represent classes & interfaces[Object is an instance of Class]. Class objects are constructed/instantiated automatically by the JVM as classes are loaded



PHASE III Reflection API

Add functionality [through config file] to match URI to controller/method name

Merge InputProductController & SaveProductController into single ProductController

Performed DATA BINDING on Product Domain Object

Access Config File through Servlet init()

DispatcherServlet:

```
public void init( ) throws ServletException {

 Map<String, Controller> handlers = new HashMap<String, Controller>();
 Map<String, String> handlerMethods = new HashMap<String, String>();

 String configFile = super.getInitParameter("configFile");
 LoadServletProperties loadServletProperties=
                                        new LoadServletProperties();
   loadServletProperties.loadControllers(configFile,handlers,handlerMethods);
}
```

Process Config File

```
 // Enumerate thru Controllers,handlers...
Enumeration  enumeration = prop.keys();
while (enumeration.hasMoreElements()) {
String key =
   (String) enumeration.nextElement();
if (prop.get(key).equals("Start")) {
    type = key;
    continue;
}
if (type.equals("Controllers"))
   controller =
     getControllerInstance((String)prop.get(key));
   controllers.put(key, controller);
else if (type.equals(“Handlers")) {
   controller = controllers.get((String)prop.get(key));
   handlers.put(key, controller);
else if (type.equals("Methods")) {
   String methodName = (String) prop.get(key);
ControllerMethod controllerMethod=getMethodDetails(controller,methodName);
   handlerMethods.put(key, controllerMethod); }
```

CONFIG FILE:

```
Controllers=Start
ProductController=mum.ProductController

Handlers=Start
/product_input=ProductController
/product_save=ProductController
/=ProductController

Methods=Start
M/product_input=inputProduct
M/product_save=saveProduct
M/=inputProduct
```

```
// Get controller based on URI EXAMPLE: /product_input=ProductController
        Controller controller =  (Controller) handlers.get(action);
// Get method details based on URI EXAMPLE: M/product_input=inputProduct
        ControllerMethod controllerMethod = handlerMethods.get(action);
```

```
// Get Controller Method parameters - setup during startup Config
Method method = controllerMethod.getMethod();
  Map<String,Object> params = controllerMethod.getParams();

Object[] methodParams =
                new  Object[method.getParameterTypes().length];
int n = 0;
if  (params.get("domainObject") != null) methodParams[n++] =
                                        params.get("domainObject");
if  (params.get("request") != null) methodParams[n++] = request;
if  (params.get("response") != null) methodParams[n++] = response;
 // If it is a POST, BIND the request parameters to Domain Object
if (request.getMethod().equals("POST"))
                    domainDataBinding(request,controllerMethod);
// FINALLY call the controller method
dispatchUrl = (String) method.invoke(controller, methodParams);
```

Data Binding

```
Enumeration<String> parameterNames = request.getParameterNames();
Object domainObject = controllerMethod.getParams().get("domainObject");
Map<String,Method> domainObjectSetters =
                              controllerMethod.getDomainObjectSetters();
while (parameterNames.hasMoreElements()) {
 String fieldName = (String) parameterNames.nextElement();
// value of the form field, e.g., name,description OR price
Object[] value = (Object[])parameterMap.get(fieldName);
domainMethod=domainObjectSetters.get(fieldName) //Method e.g.,setName()
Class<?>[] parameterTypes  = domainMethod.getParameterTypes();
 String strVal = ((String)value[0]).trim();
if (parameterTypes[0]  == String.class)
    domainMethod.invoke(domainObject, strVal); //invoke method W/string
else if (parameterTypes[0]  == Double.class)
    Double val  Double.valueOf(strVal);
   domainMethod.invoke(domainObject, val); //invoke method W/Double
else if (parameterTypes[0]  == Integer.class) {
 Integer val = Integer.valueOf(strVal);
 domainMethod.invoke(domainObject, val); //invoke method W/Integer
```

ProductController

```
public String saveProduct(Product product, HttpServletRequest request) {
        // validate Product
        ProductValidator productValidator = new ProductValidator();
        List<String> errors = productValidator.validate(product);
        if (errors.isEmpty()) {
            request.setAttribute("product", product);
            return "/WEB-INF/jsp/ProductDetails.jsp";
        } else {
            // store errors and form in a scope variable for the view
            request.setAttribute("errors", errors);
            request.setAttribute("form", product);
            return "/WEB-INF/jsp/ProductForm.jsp";
```

Compare with Slide 7

Main Point

- ALL OO constructs of Java are defined by the reflective aspect of their fundamental design.
- *The reflective aspect of OO is an example of self-referral nature of Transcendental Consciousness.*

PHASE IV DI & Annotations

DEPENDENCY INJECTION

Whenever we create object using

new()

we violate the

principle of programming to an interface rather than implementation

programming to implementation eventually results in code that is inflexible and difficult to maintain.

Annotations

Metadata - to *describe* the usage and meaning of entities like methods and classes

No direct effect on the operation of the code they annotate

Can be evaluated by “others” (e.g., frameworks)

Usage: “inline” configuration; control of lifecycle behavior

We are going to use an Annotation to implement Dependency Injection

@Autowired

```
@Documented
@Retention(java.lang.annotation.RetentionPolicy.RUNTIME)
@Target({java.lang.annotation.ElementType.FIELD})
public @interface AutoWired {}
```

Usage in ProductController.java

```
@AutoWired
 Validator productValidator;
     ...
public String saveProduct...) {
 //ProductValidator productValidator = new ProductValidator();
  List<String> errors = productValidator.validate(product);
```

@Autowired processing

Backed by configure time processing using Reflection API

```
public class ProcessAnnotations {
/*
 * Loop through Controllers looking for Annotations [@Autowired]
 */
  public static void handleAnnotations(
                        Map<String,Controller> controllers ) {

              .....
      }
```

NOTE: Yet MORE Reflection….

PHASE V More Annotation

Annotate the Controller method with URL mapping

```
@RequestMapping(value={"/","/product_input"})
public String inputProduct(HttpServletRequest request,
                           HttpServletResponse response) {
```

Identify Controllers by Annotation

```
@Controller
public class ProductController  {
```

Only process @Controller classes for other annotations

Simple Config file– list package where controllers are located

```
Controllers=Start
Controller=mum.edu.controller
```

Main Point

- The use of the Reflection API coupled with Annotations allow us to apply best practices W/R to Java Object construction and lifecycle management.
- *Understanding more reflective[fundamental] aspects of "**any concept**" makes us able to use that concept in the best way. Transcendental Consciousness is the ultimate fundamental aspect of Nature.*