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ReST

Representational State Transfer

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Web As A Resource

- Roy Fielding - co-founder - apache http server project.
    - His doctoral thesis describes REST as an architectural style
    - Why is the Web so prevalent and ubiquitous?
    - What makes the Web scale?
    - How can I apply the architecture of the Web to my own applications?

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What's ReST

- It relies on a stateless, client-server, cacheable communications protocol -- and in virtually all cases, the HTTP protocol is used.

- REST is a lightweight alternative to mechanisms like RPC (Remote Procedure Calls) and Web Services (SOAP, WSDL, et al.).

- REST is not a "standard". There will never be a W3C recommendation for REST,

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Examples

- Google search API
- Google Maps API
- Facebook People Search API

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Addressable Resources

- Every object and resource in your system is reachable through a unique identifier.
- Does not mean we expose the underlying data model as is.
    - Many times we create API models that are a combination of data models

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How is biz logic exposed

- RPC Style interface operation example:
  - val = calcSum(a,b)
- REST style interface treating the sum as a resource
  - http://host/sum?op1=a&op2=b
  - Cacheable resource
  - Idempotent

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How is biz logic exposed

OPERATION	RPC (OPERATION)	REST (RESOURCE)
Signup	POST /signup	POST /persons
Resign	POST /resign	DELETE /persons/1234
Read a person	GET /readPerson?personid=1234	GET /persons/1234
Read a person's items list	GET /readUsersItemsList?userid=1234	GET /persons/1234/items
Add an item to a person's list	POST /addItemToUsersItemsList	POST /persons /1234/items
Update an item	POST /modifyItem	PUT /items/456
Delete an item	POST /removeItem?itemId=456	DELETE /items/456

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Sometimes They Dont Fit Well

- Sometimes the concept of resource does not fit well.
- Example: google map direction finding rest api could have been called “findDirection” to indicate that its a method
  - However google makes it a resource and calls it “direction”. A noun is used instead of verb
  - http://maps.googleapis.com/maps/api/directions/json?origin=Jakkur&destination=Hebbal
  - This makes cacheing easy with http semantics
- Think of resources as classes (nouns) and not methods (verbs)

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Verbs and Meanings

VERB	MEANING	IDEMPOTENT	SAFE	CACHEABLE
GET	Reads a resource	Yes	Yes	Yes
POST	Creates a resource or triggers a data-handling process	No	No	Only cacheable if response contains explicit freshness information
PUT	Fully updates (replaces) an existing resource or create a resource	Yes	No	No
PATCH	Partially updates a resources	No	No	Only cacheable if response contains explicit freshness information
DELETE	Deletes a resource	Yes	No	No

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Constrained Interface

- APIs dont have an “action” parameter. The set of operations are pre-defined - GET/POST/PUT etc
- Builds familiarity and semantics
- Improves Interoperability
- Policy based scaling because of predictable behaviour

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Characteristics

- Resources, which are identified by logical URLs. Both state and functionality are represented using resources.

- REST interfaces should return user interface content that is independent of how the user interface will be displayed.

- A web of resources, meaning that a single resource should not be overwhelmingly large and contain too fine-grained details. Whenever relevant, a resource should contain links to additional information

- There is no connection state

- Resources should be cacheable whenever possible

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Guiding Principles Of REST

- Do not use "physical" URLs: "http://www.acme.com/inventory/product003.xml". A logical URL does not imply a physical file: “http://www.acme.com/inventory/product/003".

- Queries should not return an overload of data. If needed, provide a paging mechanism.

- Even though the REST response can be anything, make sure it's well documented

- Rather than letting clients construct URLs for additional actions, include the actual URLs with REST responses

- GET/PUT/DELETE access requests should be idempotent

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Richardson Maturity Model

- Level 0 - SOAP et all - Single verb and single URI
- Level 1 - Resources
- Level 2 - HTTP Verbs and Status Codes
- Level 3 - Hypermedia

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HATEOAS

- Hypermedia as the Engine of Application State
- The principle is that a client interacts with a network application entirely through hypermedia provided dynamically by application servers.
- Links in a document also identify state change
- Older applications usually have a list of precanned services they know exist, and they interact with a central directory server to locate these services on the network

Example of HATEOAS


```
{
   "content": [ {
       "price": 499.00,
       "description": "Apple tablet device",
       "name": "iPad",
       "links": [ {
           "rel": "self",
           "href": "http://localhost:8080/product/1"
       } ],
       "attributes": {
           "connector": "socket"
       }
   }, {
       "price": 49.00,
       "description": "Dock for iPhone/iPad",
       "name": "Dock",
       "links": [ {
           "rel": "self",
           "href": "http://localhost:8080/product/3"
       } ],
       "attributes": {
           "connector": "plug"
       }
   } ],
   "links": [ {
       "rel": "product.search",
       "href": "http://localhost:8080/product/search"
   } ]
}
```

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Link Data

- rel - indicates the type of link: next, previous, edit
- href - the actual location of the resource
- type - the content-type produced by the url

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Pagination With HATEOAS

Clients dont have to construct a set of parameters or URLs for a page.. they just use the urls in current data to reach next set of data

```
<products>
      <link rel="next" href="http://example.com/store/products?
startIndex=5"/>
      <product id="123">
         <name>headphones</name>
         <price>$16.99</price>
      </product>
   ...
   </products>
```

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REST and Scaling

- Modern backends are not consistent
    - CAP Theorem shows that consistent systems do not scale
    - We fall back on eventual consistency instead of instantaneous consistency
- Transactions are not perfect in large scale systems

Making A Purchase

- Something like amazon.com need replicated databases for failover (No concept of backups)
- An order placed on one database instance has to be replicated to all.
    - There is a moment when the data is inconsistent on other db
- Idempotency of REST operations like PUT helps just repeat operation on inconsistent instances

JAX-RS

- JAX-RS is a framework that focuses on applying Java annotations to plain Java objects to create REST APIs.

- It has annotations to bind specific URI patterns and HTTP operations to individual methods of your Java class.

- It has parameter injection annotations so that you can easily pull in information from the HTTP request.

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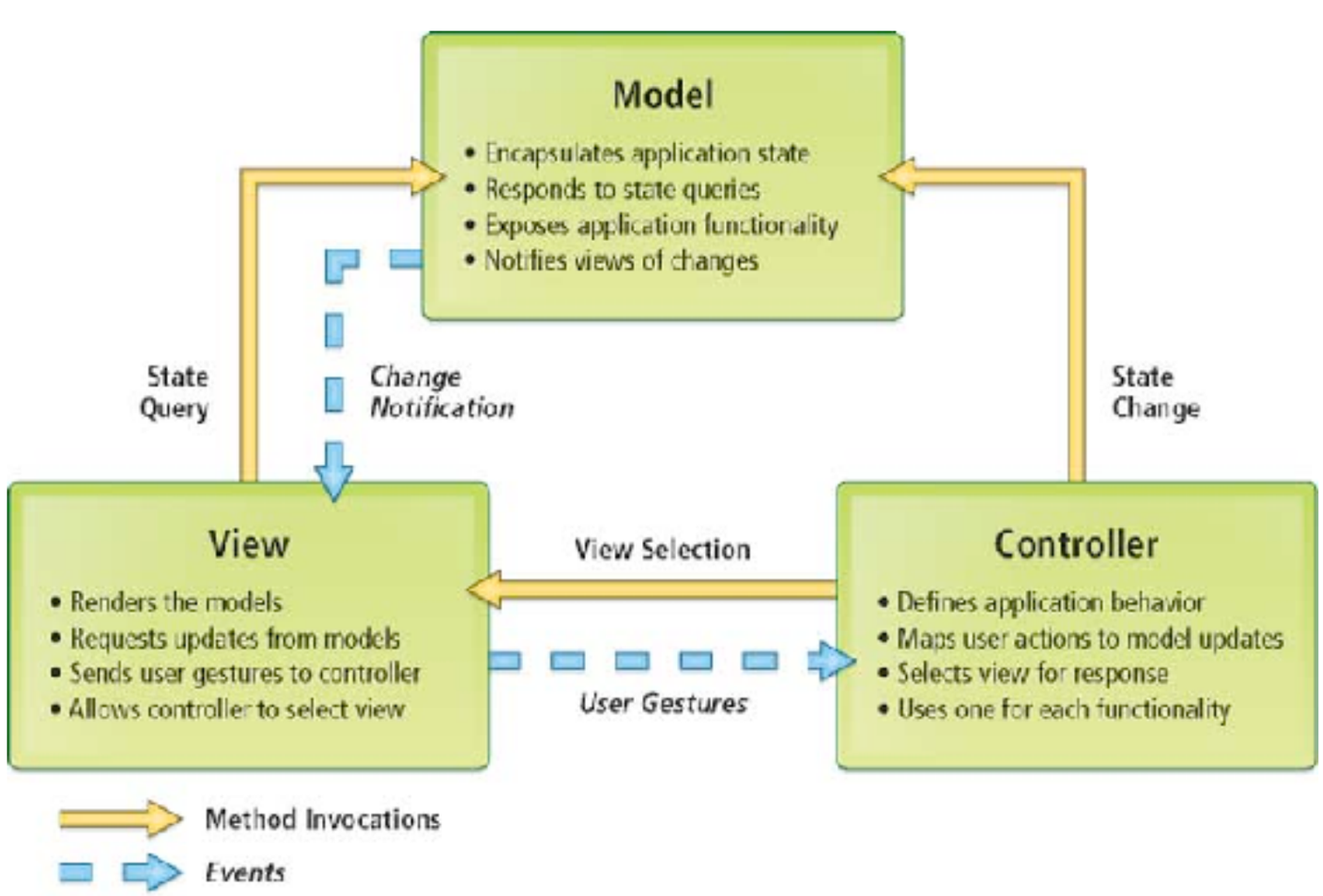
Spring Rest

- Spring Rest is built on top of Spring MVC
- Parameter and JSON handling is provided by spring and jackson libraries

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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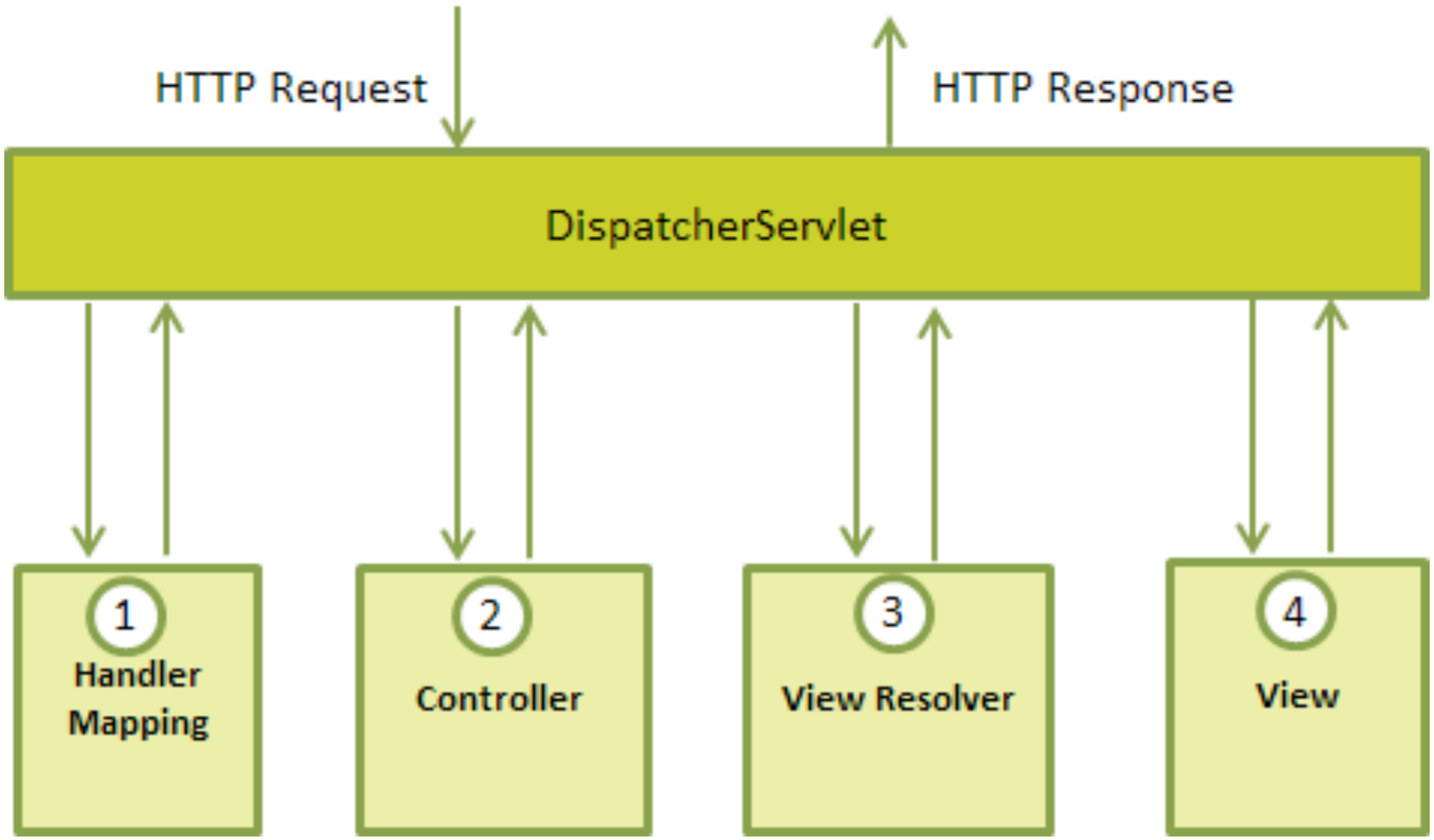
Spring MVC Flow



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Hello World

- Create a maven app with webapp archetype
- Setup dependencies on Spring MVC and related libraries
- 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>
```

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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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Lets Build REST services

- Create a maven app with webapp archetype
- Setup dependencies on Spring MVC and related libraries
- Add this to action-servlet.xml

```
<mvc:annotation-driven />
```

- Create a root resource class

```
@RestController
@RequestMapping("/users")
public class UserResource {

    @RequestMapping(method=RequestMethod.GET, value="/",
            produces=MediaType.APPLICATION_JSON_VALUE)
    public List<User> getUsers() {
        //Load a list of User objects using Hibernate and return
    }
}
```

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Using Javascript Client

- Include JQuery into a html

```
$.get("/url",function(data,status){

})

$.post(“/url",data,function(data,status){

})
```

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Demo of Postman for REST

- Postman is a chrome app that is useful for REST testing

- Along with paid upgrades for JetPack - it can run tests in a group and offer Javascript response validation

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Data Binding Type Conversions

- Primitives automatically handled
- Params can be java classes that have a constructor with a string param
- Serializable java beans
- We can define custom converter classes for types that don't fit above definition

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Lets Try It

- Implement User Creation using automatic data binding

```
@RequestMapping(method=RequestMethod.POST, value="/",
        consumes=MediaType.APPLICATION_JSON_VALUE,
        produces=MediaType.APPLICATION_JSON_VALUE)
public Map<String,String> addUsers(@RequestBody User u) throws Exception{
```

- Implement User Update

```
@RequestMapping(method=RequestMethod.PUT, value="/",
        consumes=MediaType.APPLICATION_JSON_VALUE,
        produces=MediaType.APPLICATION_JSON_VALUE)
    public Map<String,String> updateUsers(@RequestBody User u) throws Exception{
```

- Implement Delete

```
    @RequestMapping(method=RequestMethod.DELETE, value="/{uid}",
            produces=MediaType.APPLICATION_JSON_VALUE)
    public Map<String,String> deleteUsers(@PathVariable("uid") Integer id) throws
Exception{
```

- Implement User retrieval with path params /users/307

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JAX-RS Comparison
Resources & Sub-Resources

```
@Path("/maps")
public class MapsResource {


    @Path("directions")
    public DirectionsResource getDirectionsResource() {
        return new DirectionsResource();
    }

    @GET
    @Produces("application/xml")
    public Map get() { ... }
    }
}

public class DirectionsResource {

    @GET
    public Response get() { ... }

    @PUT
    @Path("{version}")
    public void put(...) {
        ...
    }
}

/services/maps/directions/
```

Content Negotiation

- Within large organizations or on the Internet, SOA applications need to be flexible enough to handle and integrate with a variety of clients and platforms.

- Different clients need different formats in order to run efficiently. Java clients might like their data within an XML format. Ajax clients work a lot better with JSON.

- Clients will need content in different languages

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Http Content Neg

```
GET http://example.com/stuff
Accept: application/xml, application/json
```

- the client is asking the server for /stuff formatted in either XML or JSON. If the server is unable to provide the desired format, it will respond with a status code of 406, “Not Acceptable.”

- Accept: text/*;q=0.9, */*;q=0.1, audio/mpeg, application/xml;q=0.5

```
Preference order:

audio/mpeg
text/*
application/xml
*/*
```

- Accept: text/*, text/html;level=1, */*, application/xml

```
Preference order:

text/html;level=1
application/xml
text/*
*/*
```

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Language Neg

- Accept-Language: en-us, es, fr
    - Requesting content in english, spanish and french
- Accept-Language: fr;q=1.0, es;q=1.0, en=0.1
    - French or Spanish preferred, accepts english

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Design Principle - Complexity In Data

- An important principle of REST is that the complexities of your resources are encapsulated within the data formats

- Location information (URIs) and protocol methods remain fixed, data formats can evolve.

- Since complexity is confined to your data formats, clients can use media types to ask for different format versions.

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Versioning

- One way to version REST is using different urls for different versions
    - http://host/services/v1/users and http://host/services/v2/users
- Another way to do it using custom content types on the same url
    - application/vnd.myapp.users-v1+json and application/vnd.myapp.users-v2+json
- Versionless extensibility driven with HATEOAS

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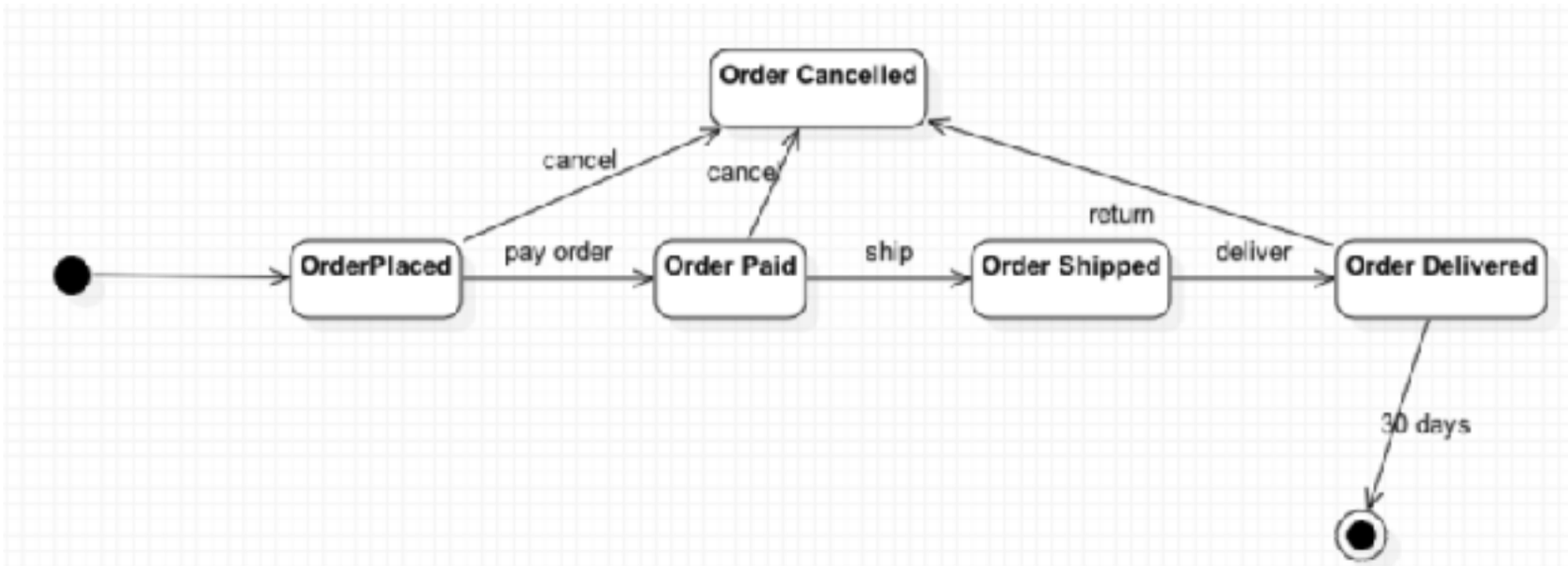
HATEOAS

- location transparency. In a RESTful system that leverages HATEOAS, very few URIs are published to the outside world.
    - Clients only know logical names of resources - just like in a naming service
- Things like pagination work gracefully without the client knowing details of pagination params

Defining State Machine With HATEOAS



- States of a resource sometimes determine next available states

```
{
    order_id: 3,
    order_date: '2014-01-01',
    city: 'Bangalore',
    state: 'placed'
    links: [ {
         "rel": "cancel",
         "href": "http://localhost:8080/order/3?cancelled=true"
     },{
         "rel": "pay",
         "href": "http://localhost:8080/order/3?pay=true"
     } ]
}
```

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Security

- Based on JEE Role based and principal based security
- Basic authentication flow shown below

```
GET /customers/333 HTTP/1.1

HTTP/1.1 401 Unauthorized
WWW-Authenticate: Basic realm="CustomerDB Realm"

GET /customers/333 HTTP/1.1
Authorization: Basic YmJ1cmtlOmdlaGVpbQ==
```

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Auth Configuration

```
<?xml version="1.0"?>
<web-app>
   <security-constraint>
      <web-resource-collection>
         <web-resource-name>users</web-resource-name>
         <url-pattern>/services/users</url-pattern>
         <http-method>POST</http-method>
      </web-resource-collection>
      <auth-constraint>
         <role-name>admin</role-name>
      </auth-constraint>
   </security-constraint>
   <login-config>
       <auth-method>BASIC</auth-method>
       <realm-name>jaxrs</realm-name>
   </login-config>
   <security-role>
       <role-name>admin</role-name>
   </security-role>
</web-app>
```

```
@Path("/users")
@RolesAllowed({"ADMIN"})
public class UserResource {
```

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Programmatic Security

- When role based is not enough:
  - I can see my salary record not everyone else's

```
public interface SecurityContext {
    public Principal getUserPrincipal();
    public boolean isUserInRole(String role);
    public boolean isSecure();
    public String getAuthenticationScheme();
}
```

- Security context can be injected into the method or class

```
@Context SecurityContext sec
```