REST Implementation

In REST architecture, a REST Server simply provides access to resources and REST client accesses and modifies the resources.

Here each resource is identified by URIs/ global IDs. REST uses various representation to represent a resource like text, JSON, XML. JSON is the most popular one.

HTTP methods

Following four HTTP methods are commonly used in REST based architecture.

GET − Provides a read only access to a resource.

POST − Used to create a new resource.

DELETE − Used to remove a resource.

PUT − Used to update a existing resource or create a new resource.

Introduction to RESTFul web services

•A web service is a collection of open protocols and standards used for exchanging data between applications or systems.

•Software applications written in various programming languages and running on various platforms can use web services to exchange data over computer networks like the Internet in a manner similar to inter-process communication on a single computer.

•This interoperability (e.g., between Java and Python, or Windows and Linux applications) is due to the use of open standards.

Web services based on REST Architecture are known as RESTful web services.

These web services uses HTTP methods to implement the concept of REST architecture.

A RESTful web service usually defines a URI, Uniform Resource Identifier a service, provides resource representation such as JSON and set of HTTP Methods.

Creating RESTFul Webservice

we'll create a webservice say user management with following functionalities −

Sr.No	URI	HTTP Method	POST body	Result
1	/UserService/users	GET	empty	Show list of all the users.
2	/UserService/addUser	POST	JSON String	Add details of new user.
3	/UserService/getUser/:id	GET	empty	Show details of a user.

RESTful Application

- RESTful Resources
- RESTful Messages
- RESTful Addressing
- RESTful Methods
- RESTful Statelessness
- RESTful Caching
- RESTful Security
- RESTful Java (JAX-RS)

RESTful Resources

What is a Resource?

•REST architecture treats every content as a resource.

•These resources can be Text Files, Html Pages, Images, Videos or Dynamic Business Data. REST Server simply provides access to resources and REST client accesses and modifies the resources.

•Here each resource is identified by URIs/ Global IDs. REST uses various representations to represent a resource where Text, JSON, XML.

•The most popular representations of resources are XML and JSON.

Representation of Resources

•A resource in REST is a similar Object in Object Oriented Programming or is like an Entity in a Database.

•Once a resource is identified then its representation is to be decided using a standard format so that the server can send the resource in the above said format and client can understand the same format.

```
<user>
   <id>1</id>
   <name>Mahesh</name>
   <profession>Teacher</profession>
</user>
```

The same resource can be represented in JSON format as follows −

```
{
"id":1,
"name":"Mahesh",
"profession":"Teacher“
}
```

Good Resources Representation

- REST does not impose any restriction on the format of a resource representation.
- A client can ask for JSON representation whereas another client may ask for XML representation of the same resource to the server and so on.
- It is the responsibility of the REST server to pass the client the resource in the format that the client understands.

Following are some important points to be considered while designing a representation format of a resource in RESTful Web Services.

Understandability − Both the Server and the Client should be able to understand and utilize the representation format of the resource.

Completeness − Format should be able to represent a resource completely. For example, a resource can contain another resource. Format should be able to represent simple as well as complex structures of resources.

Linkablity − A resource can have a linkage to another resource, a format should be able to handle such situations.

However, at present most of the web services are representing resources using either XML or JSON format. There are plenty of libraries and tools available to understand, parse, and modify XML and JSON data

RESTful - Messages

RESTful Web Services make use of HTTP protocols as a medium of communication between client and server. A client sends a message in form of a HTTP Request and the server responds in the form of an HTTP Response. This technique is termed as Messaging. These messages contain message data and metadata i.e. information about message itself. Let us have a look on the HTTP Request and HTTP Response messages for HTTP 1.1.

HTTP Request

HTTP Request

An HTTP Request has five major parts −

Verb − Indicates the HTTP methods such as GET, POST, DELETE, PUT, etc.

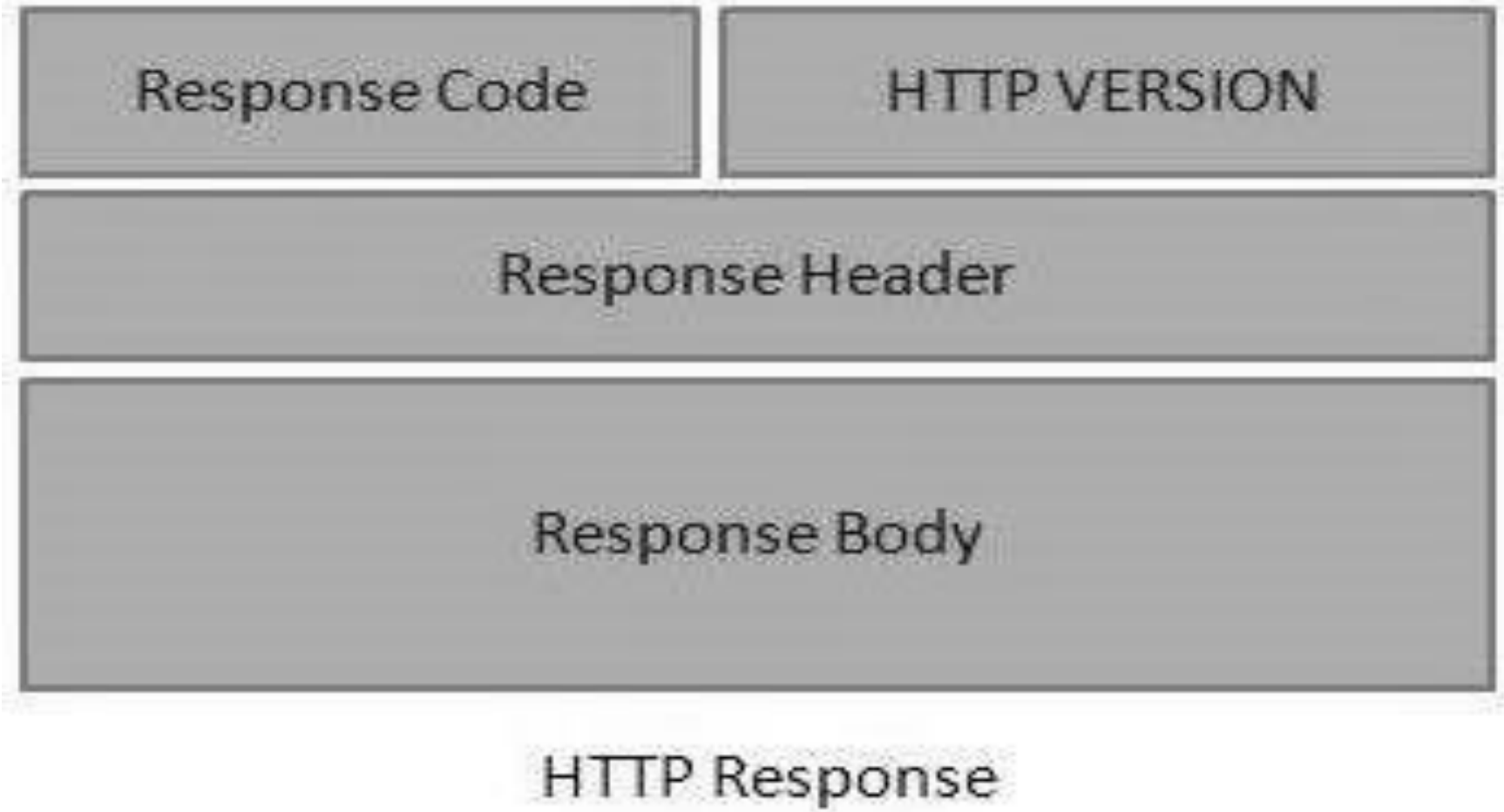
URI − Uniform Resource Identifier (URI) to identify the resource on the server.

HTTP Version − Indicates the HTTP version. For example, HTTP v1.1.

Request Header − Contains metadata for the HTTP Request message as key-value pairs. For example, client (or browser) type, format supported by the client, format of the message body, cache settings, etc.

Request Body − Message content or Resource representation.

HTTP Response



HTTP Response

An HTTP Response has four major parts −

Status/Response Code − Indicates the Server status for the requested resource. For example, 404 means resource not found and 200 means response is ok.

HTTP Version − Indicates the HTTP version. For example HTTP v1.1.

Response Header − Contains metadata for the HTTP Response message as keyvalue pairs. For example, content length, content type, response date, server type, etc.

Response Body − Response message content or Resource representation.

RESTful -Addressing

Addressing refers to locating a resource or multiple resources lying on the server. It is analogous to locate a postal address of a person.

Each resource in REST architecture is identified by its URI (Uniform Resource Identifier). A URI is of the following format −

```
<protocol>://<service-name>/<ResourceType>/
<ResourceID>
```

Purpose of an URI is to locate a resource(s) on the server hosting the web service. Another important attribute of a request is VERB which identifies the operation to be performed on the resource. For example, if the URI is **http://localhost:8080/UserManagement/rest/UserService/users** and the VERB is GET.

Constructing a Standard URI

The following are important points to be considered while designing a URI −

Use Plural Noun − Use plural noun to define resources. For example, we've used users to identify users as a resource.

Avoid using spaces − Use underscore (_) or hyphen (-) when using a long resource name. For example, use authorized_users instead of authorized%20users.

Use lowercase letters − Although URI is case-insensitive, it is a good practice to keep the url in lower case letters only.

Maintain Backward Compatibility − As Web Service is a public service, a URI once made public should always be available. In case, URI gets updated, redirect the older URI to a new URI using the HTTP Status code, 300.

Use HTTP Verb − Always use HTTP Verb like GET, PUT and DELETE to do the operations on the resource. It is not good to use operations name in the URI.

Example
Following is an example of a poor URI to fetch a user.

http://localhost:8080/UserManagement/rest/UserService/getUser/1

Following is an example of a good URI to fetch a user.

http://localhost:8080/UserManagement/rest/UserService/users/1

RESTful web service makes heavy uses of HTTP verbs to determine the operation to be carried out on the specified resource(s). Following table states the examples of common use of HTTP Verbs.

HTTP Method	GET
URI	http://localhost:8080/UserManagement/rest/UserService/users
Operation	Get list of users
Operation Type	Read Only

HTTP Method	GET
URI	http://localhost:8080/UserManagement/rest/UserService/users/1
Operation	Get user of Id 1
Operation Type	Read Only

HTTP Method	POST
URI	http://localhost:8080/UserManagement/rest/UserService/users/2
Operation	Insert user with Id 2
Operation Type	Non-Idempotent

HTTP Method	PUT
URI	http://localhost:8080/UserManagement/rest/UserService/users/2
Operation	Update User with Id 2
Operation Type	N/A

HTTP Method	DELETE
URI	http://localhost:8080/UserManagement/rest/UserService/users/1
Operation	Delete User with Id 1
Operation Type	Idempotent

HTTP Method	OPTIONS
URI	http://localhost:8080/UserManagement/rest/UserService/users
Operation	List the supported operations in web service
Operation Type	Read Only

HTTP Method	HEAD
URI	http://localhost:8080/UserManagement/rest/UserService/users
Operation	Returns only HTTP Header, no Body
Operation Type	Read Only

Important points to be considered:

•GET operations are read only and are safe.

•PUT and DELETE operations are idempotent means their result will always same no matter how many times these operations are invoked.

•PUT and POST operation are nearly same with the difference lying only in the result where PUT operation is idempotent and POST operation can cause different result.

RESTful - Statelessness

- As per the REST architecture, a RESTful Web Service should not keep a client state on the server. This restriction is called Statelessness.
- It is the responsibility of the client to pass its context to the server and then the server can store this context to process the client's further request.
- For example, session maintained by server is identified by session identifier passed by the client.
- RESTful Web Services should adhere to this restriction.

Consider the following URL –

https://localhost:8080/UserManagement/rest/UserService/users/1

If you hit the above url using your browser or using a java based client or using Postman, result will always be the User XML whose Id is 1 because the server does not store any information about the client.

```
<user>
   <id>1</id>
   <name>mahesh</name>
   <profession>1</profession>
</user>
```

Advantages of Statelessness

Following are the benefits of statelessness in RESTful Web Services −

•Web services can treat each method request independently.

•Web services need not maintain the client's previous interactions. It simplifies the application design.

•As HTTP is itself a statelessness protocol, RESTful Web Services work seamlessly with the HTTP protocols.

Disadvantages of Statelessness

Following are the disadvantages of statelessness in RESTful Web Services −

Web services need to get extra information in each request and then interpret to get the client's state in case the client interactions are to be taken care of.

RESTful - caching

- Caching refers to storing the server response in the client itself, so that a client need not make a server request for the same resource again and again.
- A server response should have information about how caching is to be done, so that a client caches the response for a time-period or never caches the server response.
- Following are the headers which a server response can have in order to configure a client's caching.

Sr.No.	Header & Description
1	**Date** Date and Time of the resource when it was created.
2	**Last Modified** Date and Time of the resource when it was last modified.
3	**Cache-Control** Primary header to control caching.
4	**Expires** Expiration date and time of caching.
5	**Age** Duration in seconds from when resource was fetched from the server.

Cache-Control Header

Following are the details of a Cache-Control header −

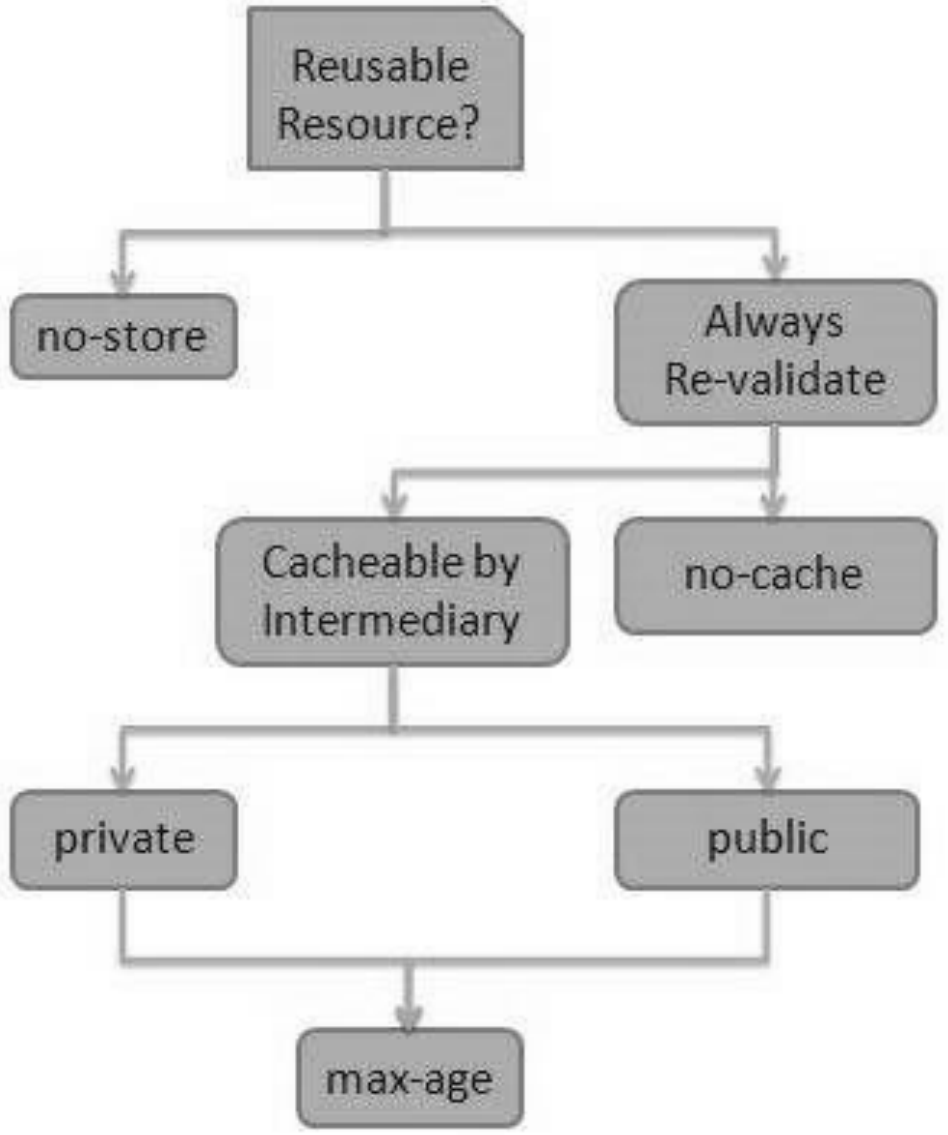
Sr.No.	Directive & Description
1	**Public** Indicates that resource is cacheable by any component.
2	**Private** Indicates that resource is cacheable only by the client and the server, no intermediary can cache the resource.
3	**no-cache/no-store** Indicates that a resource is not cacheable.
4	**max-age** Indicates the caching is valid up to max-age in seconds. After this, client has to make another request.
5	**must-revalidate** Indication to server to revalidate resource if max-age has passed.

Best Practices

•Always keep static contents like images, CSS, JavaScript cacheable, with expiration date of 2 to 3 days.

•Never keep expiry date too high.

•Dynamic content should be cached for a few hours only.



RESTful - Security

As RESTful Web Services work with HTTP URL Paths, it is very important to safeguard a RESTful Web Service in the same manner as a website is secured.

Following are the best practices to be adhered to while designing a RESTful Web Service

Validation − Validate all inputs on the server. Protect your server against SQL or NoSQL injection attacks.

Session Based Authentication − Use session based authentication to authenticate a user whenever a request is made to a Web Service method.

No Sensitive Data in the URL − Never use username, password or session token in a URL, these values should be passed to Web Service via the POST method.

Restriction on Method Execution − Allow restricted use of methods like GET, POST and DELETE methods. The GET method should not be able to delete data.

Validate Malformed XML/JSON − Check for well-formed input passed to a web service method.

Throw generic Error Messages − A web service method should use HTTP error messages like 403 to show access forbidden, etc.

HTTP Code

Sr.No	HTTP Code & Description
1	**200** **OK** – shows success.
2	**201** **CREATED** – when a resource is successfully created using POST or PUT request. Returns link to the newly created resource using the location header.
3	**204** **NO CONTENT** – when response body is empty. For example, a DELETE request.
4	**304** **NOT MODIFIED** – used to reduce network bandwidth usage in case of conditional GET requests. Response body should be empty. Headers should have date, location, etc.
5	**400** **BAD REQUEST** – states that an invalid input is provided. For example, validation error, missing data.

6	**401** **UNAUTHORIZED** − states that user is using invalid or wrong authentication token.
7	**403** **FORBIDDEN** − states that the user is not having access to the method being used. For example, Delete access without admin rights.
8	**404** **NOT FOUND** − states that the method is not available.
9	**409** **CONFLICT** − states conflict situation while executing the method. For example, adding duplicate entry.
10	**500** **INTERNAL SERVER ERROR** − states that the server has thrown some exception while executing the method.

RESTful- JAVA – JAX-RS

- JAX-RS stands for JAVA API for RESTful Web Services. JAX-RS is a JAVA based programming language API and specification to provide support for created RESTful Web Services.
- Its 2.0 version was released on the 24th May 2013. JAX-RS uses annotations available from Java SE 5 to simplify the development of JAVA based web services creation and deployment.
- It also provides supports for creating clients for RESTful Web Services.

Specifications

Following are the most commonly used annotations to map a resource as a web service resource.

Sr.No.	Annotation & Description
1	**@Path** Relative path of the resource class/method.
2	**@GET** HTTP Get request, used to fetch resource.
3	**@PUT** HTTP PUT request, used to update resource.
4	**@POST** HTTP POST request, used to create a new resource.
5	**@DELETE** HTTP DELETE request, used to delete resource.

6	**@HEAD** HTTP HEAD request, used to get status of method availability.
7	**@Produces** States the HTTP Response generated by web service. For example, APPLICATION/XML, TEXT/HTML, APPLICATION/JSON etc.
8	**@Consumes** States the HTTP Request type. For example, application/x-www-formurlencoded to accept form data in HTTP body during POST request.
9	**@PathParam** Binds the parameter passed to the method to a value in path.
10	**@QueryParam** Binds the parameter passed to method to a query parameter in the path.

11	**@MatrixParam** Binds the parameter passed to the method to a HTTP matrix parameter in path.
12	**@HeaderParam** Binds the parameter passed to the method to a HTTP header.
13	**@CookieParam** Binds the parameter passed to the method to a Cookie.
14	**@FormParam** Binds the parameter passed to the method to a form value.
15	**@DefaultValue** Assigns a default value to a parameter passed to the method.
16	**@Context** Context of the resource. For example, HTTPRequest as a context.