RESTFul Web Services (An Enabler of Cloud Computing) Fundamentals

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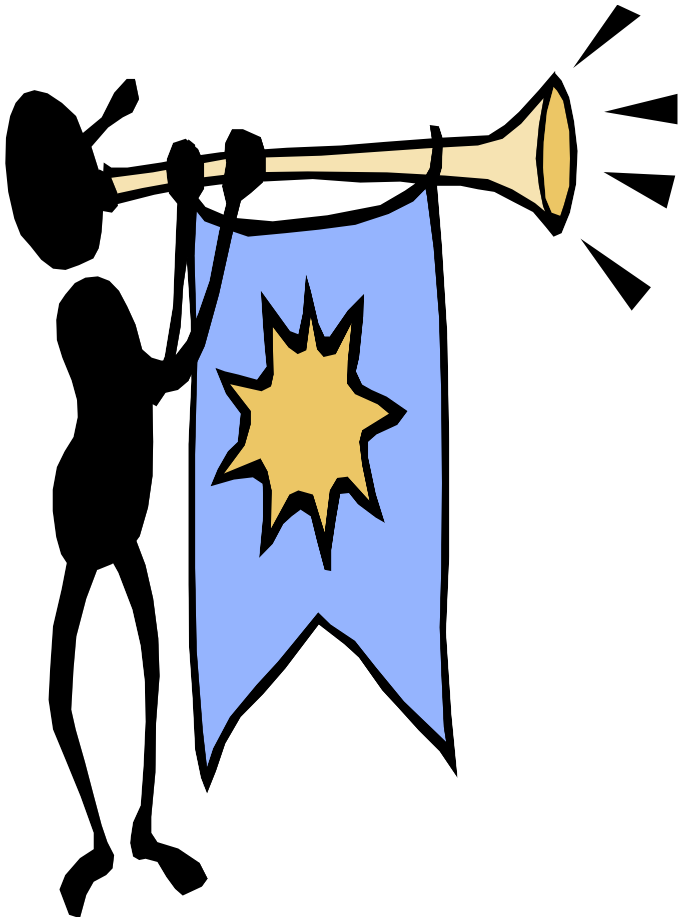
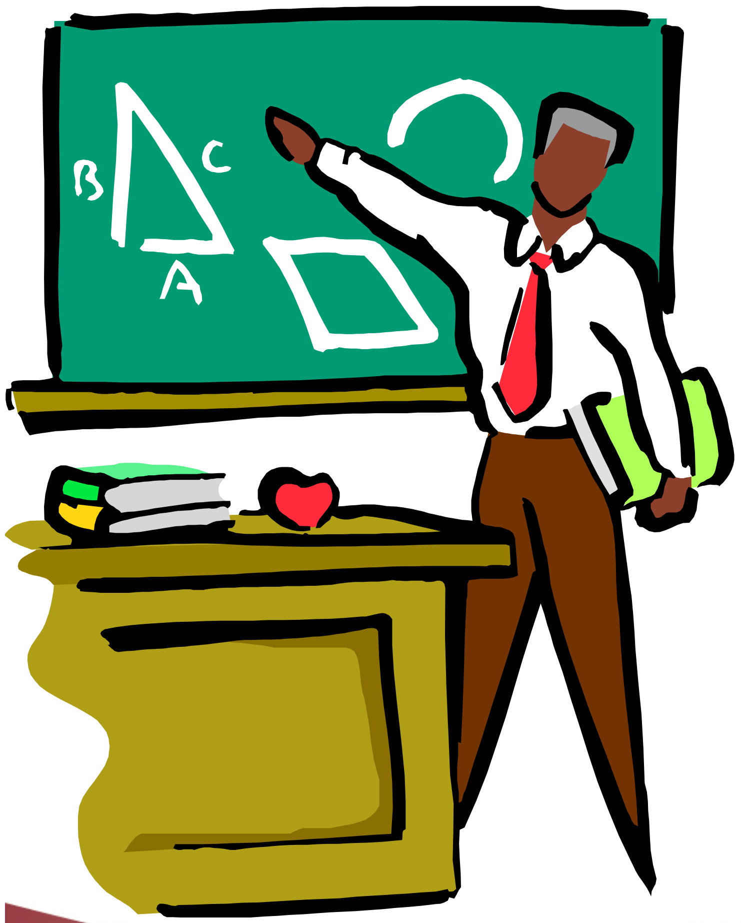
Outline



1. Web services in general
2. Detailed presentation of REST
3. REST Case studies
   - Hypervisor/Containers API
   - Openstack compute API
   - Messaging
   - Conferencing

Web Services in general

Web Services in General



1. Definition and principles
2. Web services and Cloud Computing
2. Technologies

Web Services

- RESTFul Web Services (Focus of this course)
- SOAP – BASED WEB SERVICES (Legacy – less and less used)

Definitions and principles

“The term Web Services refers to an architecture that allows applications (on the Web) to talk to each other. Period. End of statement”

Adam Bobsworth in ACM Queue, Vol1, No1

Definitions and principles

The three fundamental principles, still according to Adam Bobsworth:

1. Coarse grained approach (I.e. high level interface)
2. Loose coupling (e.g. application A which talks to application B should not necessarily be re-written if application B is modified)
3. Synchronous mode of communication, but also asynchronous mode

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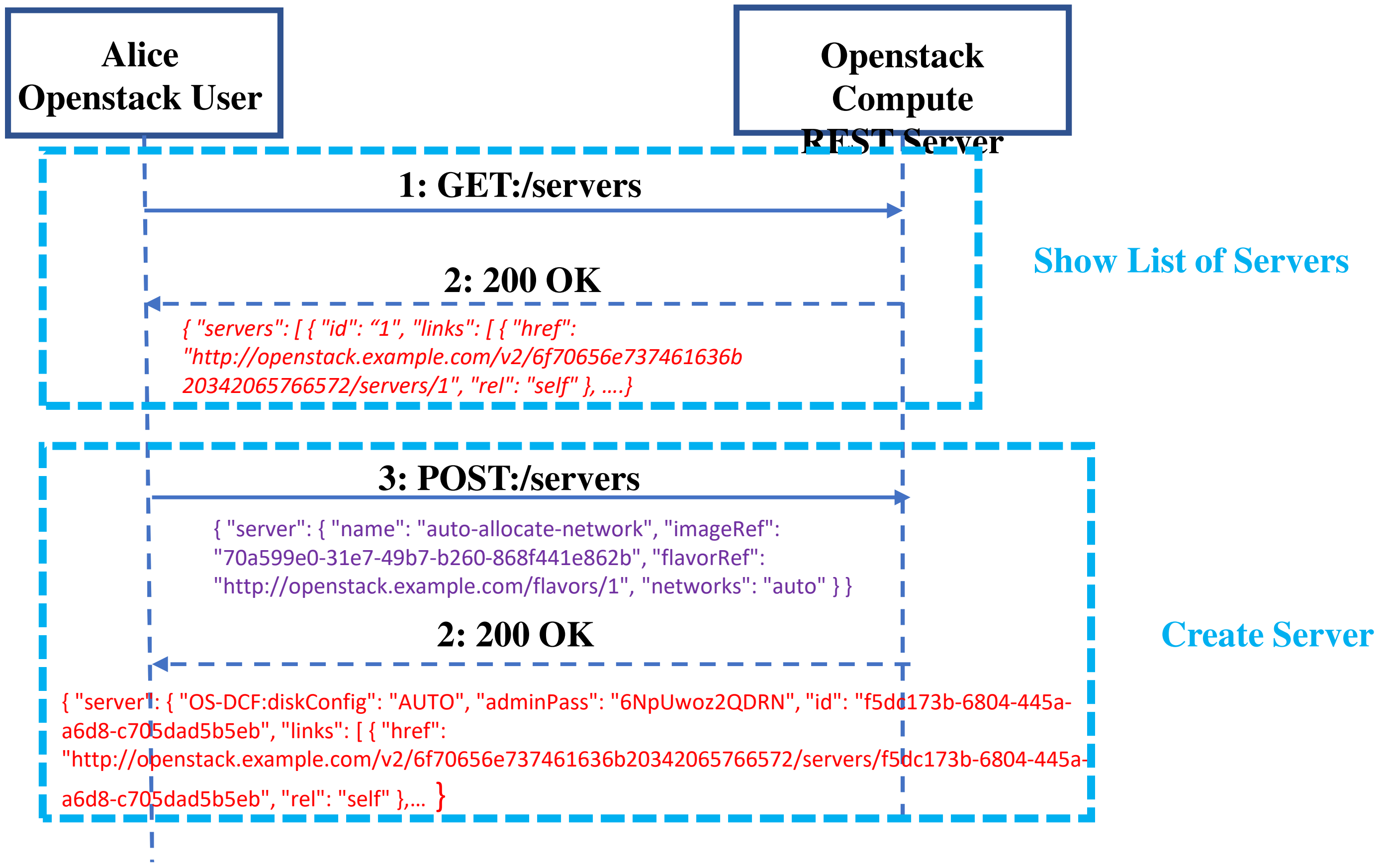
Web service and Cloud: Illustration IaaS level (Openstack REST interface)



{ "servers": [{ "id": "1", "links": [{ "href": "http://openstack.example.com/v2/6f70656e737461636b 20342065766572/servers/1", "rel": "self" }, ...}

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Web services and Cloud Computing (Illustration at the SaaS level) Zoom Developer API https://developers.zoom.us/docs/api/ (accessed on September 27, 2023)

Meeting

Overview

REST API

Webhooks

Master account API

Zoom Phone

Overview

REST API

Webhooks

Master account API

Web services and Cloud Computing (Illustration at the SaaS level) Zoom Developer blog (Processing Zoom audio in real time in order to feed it to an AI box such as NLP box) https://developers.zoom.us/blog/windows-msdk-realtime-audio/ (accessed on September 27, 2023)

Underlying architecture
Demos
Code

Technologies

Protocol:
HTTP (Both REST and SOAP Based Web services)

Data format

- XML (Both REST and SOAP)
- Other formats (REST only) – Some examples:
  - JSON
  - Plain Text

HTTP

HTTP (HyperText Transfer Protocol)

- Is an application-level protocol for distributed, collaborative, hypermedia information systems
  - HTTP has been in use since 1990
  - HTTP is a request-response protocol
  - HTTP requests relates to resources
    - A resource is any object or service network that can be identified by a URI (Universal Resource Identifier)

HTTP

Client

- A program that establishes connections for the purpose of sending requests

User Agent

- The client which initiates a request (e.g. browser)

- Note
  - A request may pass through several servers

HTTP

Server

- An application program that accepts connections in order to service requests by sending back responses
- A given program may be capable of being both a client and a server
- The role depends on connections

HTTP

- Origin server
  - The server on which a given resource resides or is to be created
- Proxy server
  - An intermediary program which acts as both a server and a client for the purpose of making requests on behalf of other clients
- Gateway server
  - receives requests as if it were the origin server for the requested resource, and forwards the request to another server
  - Is transparent to the client

HTTP

HTTP-message = Request | Response

generic-message = start-line
*(message-header CRLF)
CRLF
[message-body]

start-line = Request-Line | Status-Line

HTTP

HEAD
- retrieve meta-information about a web page, without retrieving the page content (ex: get the date for last modification)

GET
- retrieve the page content

PUT
- store the enclosed content under the supplied Request-URI

POST
- add the entity enclosed in the request as a new subordinate of the resource identified by the Request-URI
  - E.g.
    - Post a message to a mailinglist
    - Extend a database by appending information
    - Transfer a form data

HTTP

DELETE

- Deletes the page

TRACE

- Debug

OPTIONS

- Allows the client to discover the options supported by the server supporte

CONNECT

- Not used currently

HTTP

The built-in HTTP request methods.

Method	Description
GET	Request to read a Web page
HEAD	Request to read a Web page's header
PUT	Request to store a Web page
POST	Append to a named resource (e.g., a Web page)
DELETE	Remove the Web page
TRACE	Echo the incoming request
CONNECT	Reserved for future use
OPTIONS	Query certain options

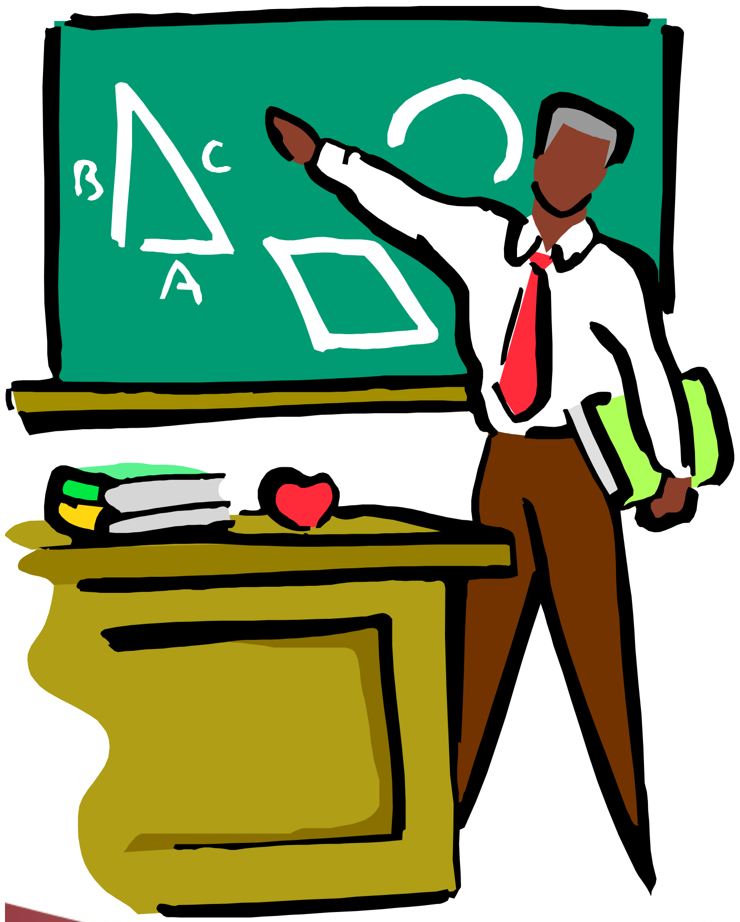
HTTP

The status code response groups.

Code	Meaning	Examples
1xx	Information	100 = server agrees to handle client's request
2xx	Success	200 = request succeeded; 204 = no content present
3xx	Redirection	301 = page moved; 304 = cached page still valid
4xx	Client error	403 = forbidden page; 404 = page not found
5xx	Server error	500 = internal server error; 503 = try again later

Detailed presentation of REST

RESTFul Web Services



Introduction

- What about using the Web’s basic technologies (e.g. HTTP) as a platform for distributed services?
  - This is what is REST about.

Introduction

- REST was first coined by Roy Fielding in his Ph.D. dissertation in 2000
- It is a network architectural style for distributed hypermedia systems.

Introduction

- REST is a way to reunite the programmable web with the human web.
- It is simple
  - Uses existing web standards
  - The necessary infrastructure has already become pervasive
  - RESTFull web services are lightweight
  - HTTP traverse firewall

Introduction

- RESTFul web services are easy for clients to use
- Relies on HTTP and inherits its advantages, mainly
  - Statelessness
  - Addressability
  - Unified interface

Resource-Oriented Architecture

- The Resource-Oriented Architecture (ROA)
  - Is a RESTful architecture
  - Provides a commonsense set of rules for designing RESTful web services

Resource-Oriented Architecture

- Concepts
  - Resources
    - Resources names (Unified Resource Identifiers-URIs)
    - Resources representations
    - Links between resources
- Key properties:
  - Addressability
  - Statelessness
  - Uniform interface

Resources

- What's a Resource?
  - A resource is any information that
    - can be named
    - Is important enough to be referenced as a thing in itself
  - A resource may be a physical object or an abstract concept
  - e.g.
    - a document
    - a row in a database
    - the result of running an algorithm.

Resources

- Naming:
  - Unified Resource Identifier (URI)
    - The URI is the name and address of a resource
    - Each resource should have at least one URI
    - URIs should have a structure and should vary in predictable ways

Resource

Representation

- A representation is any useful information about the state of a resource
- Different representation formats can be used (Unlike SOAP based Web services)
  - *plain-text*
  - *JSON*
  - XML
  - XHTML
  - ….

Resource

…

- In most RESTful web services, representations are hypermedia
  - i.e. documents that contain data, and links to other resources.

Properties

- Addressability
  - An application is addressable if it exposes a URI for every piece of information it serves
  - This may be an infinite number of URIs
    - e.g. for search results
      - *http://www.google.com/search?q=jellyfish*

Properties

- Statelessness
  - The state should stay on the client side, and be transmitted to the server for every request that needs it.
    - Makes the protocol simpler
    - Ease load balancing

Properties

- Uniform interface
  - *HTTP GET:*
    - Retrieve a representation of a resource
  - *HTTP PUT*
    - Create a new resource, where the client is in charge of creating the resource URI: *HTTP PUT* to the new URI
    - Modify an existing resource: *HTTP PUT* to an existing URI
  - *HTTP POST:*
    - Create a new resource, where the server is in charge of creating the resource URI: *HTTP POST* to the URI of the superordinate of the new resource
  - *HTTP DELETE:*
    - Delete an existing resource:
  - HTTP HEAD:
    - Fetch metadata about a resource
  - HTTP OPTIONS:
    - Lets the client discover what it’s allowed to do with a resource.

Examples of tool kits

Python
- Django REST

Java
- Play
- Jersey

Examples of RESTful Web Services

- Examples of existing RESTful web services include:
  - Amazon's Simple Storage Service (S3) (*http://aws.amazon.com/s3*) (Accessed on September, 23, 2023)
  - Oracle Cloud IaaS
  https://docs.oracle.com/en-us/iaas/api/ (Accessed on September 23, 2023)

The End