Web Services and REST

Introduction

- Web sites are normally accessed by a browser guided by a person
- But we have seen that **programs** can also access a web site, return one or more pages, and scrape the site for information
- Web Services is the idea of offering the capabilities/information on a web site via a programming interface, so application programs can more readily access the information on the site
- *Web Services* are APIs for accessing a website's information across the Internet

Introduction (cont'd)

- The implementation of Web Services is roughly divided into three categories:
  - *Big Web Services* which involve XML messages that are communicated by the Simple Object Access Protocol (SOAP); the API is formally described using the Web Services Description Language (WSDL). These services are normally used for server-to-server communication, using additional protocols like XML Security and XML Encryption.
  - *REST* (Representational State Transfer) *Services* which use HTTP methods PUT, GET, POST and DELETE.
  - *Cloud Services* which provide cloud storage, application hosting, content delivery, and other hosting services.
- All three types of Web Services provide access through APIs.
- The rest of the slides will cover **REST** Services and **Cloud** Services

REST Services

- Many web sites are now offering their facilities through REST Web Services
- REST Services can be used to access sites that perform the following functions:
  - Web Search (e.g. Google Custom Search)
  - Geolocation (e.g. Google Maps Geolocation API)
  - Photo Sharing (e.g. SmugMug's Flickr)
  - Social Networking (e.g. Facebook, Twitter)
  - Mapping (e.g. Google Maps, Bing Maps)
- Access is provided using one or both of these methods:
  - **Direct URL**, returning a response in one or more formats (XML, JSON, PHP)
  - **Library-based APIs**, embedded in JavaScript, Java, C#, Objective-C and other source and binary library formats
- Many of these services now require or include ***OAuth* user authentication**
  - Oauth is a standard for clients to access server resources on behalf of a resource owner
  - E.g. see http://en.wikipedia.org/wiki/OAuth
- Many of these services limit daily usage by a single website, and require payment when the thresholds are breached

Cloud Services

- Cloud Services covers a variety of hosting services:
  - Application Hosting (e.g., AWS, Google App Engine, FireHost, Microsoft Azure)
  - Backup and Storage (e.g., AWS)
  - Content Delivery (e.g., Netflix hosted by AWS)
  - E-commerce (Amazon.com e-commerce)
  - Media Hosting (e.g., Microsoft Azure, RackSpace, Streaming Media Hosting)
  - DNS Protection Services (e.g., CloudFlare)
  - Consumer Cloud Storage (e.g., Apple iCloud Drive, Dropbox, Microsoft OneDrive, Google Drive)
- Access is provided using one or both of these methods:
  - Dashboard
  - Library-based APIs, embedded in Java, C#, Objective-C and other binary library formats
- All these services are commercial services that require monthly payments
- The consumer cloud services provide limited, free basic storage

REST (Representational State Transfer)

- REST is a style of software architecture for distributed hypermedia systems
  - Initially proposed by **Roy Fielding** in a 2000 doctoral dissertation (remember which RFC he was involved with? The HTTP specification.) He co-founded the Apache HTTP Project.
  - See: http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm
  - The World Wide Web is an example of REST
- There are three fundamental aspects of the REST Design Pattern
  - 1. **client**, 2. **servers** and 3. **resources**
  - Resources are typically represented as documents
  - Systems that follow Fielding's REST principles are often referred to as ***RESTful***;

Resources

Every distinguishable entity is a resource

URLs

Every resource is uniquely identified by a URL

Simple Operations

(PUT,GET,POST,DELETE)

REST versus Other Approaches

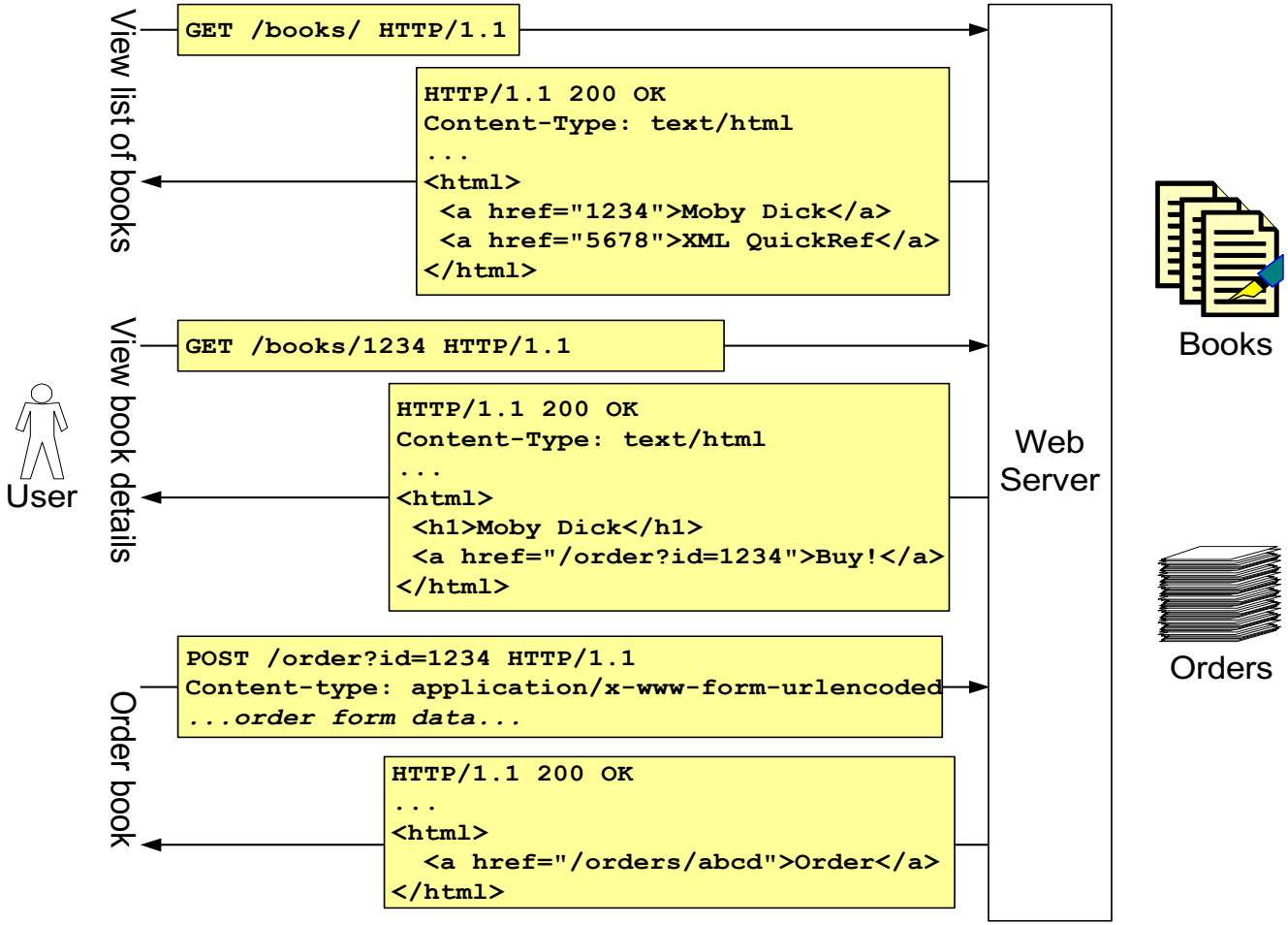
- **REST**
  - Software architectural style for distributed hypermedia systems like WWW
  - Quickly gained popularity through its **simplicity**
- **SOAP**
  - Protocol for exchanging XML-based message, normally using HTTP
  - Much more robust way to make requests, but more robust than most APIs need
  - More **complicated** to use
    - https://www.w3schools.com/xml/xml_soap.asp
- **XML-RPC**
  - RPC protocol with XML as an encoding and HTTP as a transport
  - More complex than REST but much simpler than SOAP
  - Supported by Python:
    - https://docs.python.org/3/library/xmlrpc.html
- **JSON-RPC**
  - RPC protocol encoded in JSON instead of XML
  - Very simple protocol (and very similar to XML-RPC)
    - https://www.jsonrpc.org/specification

REST as Lightweight Web Services

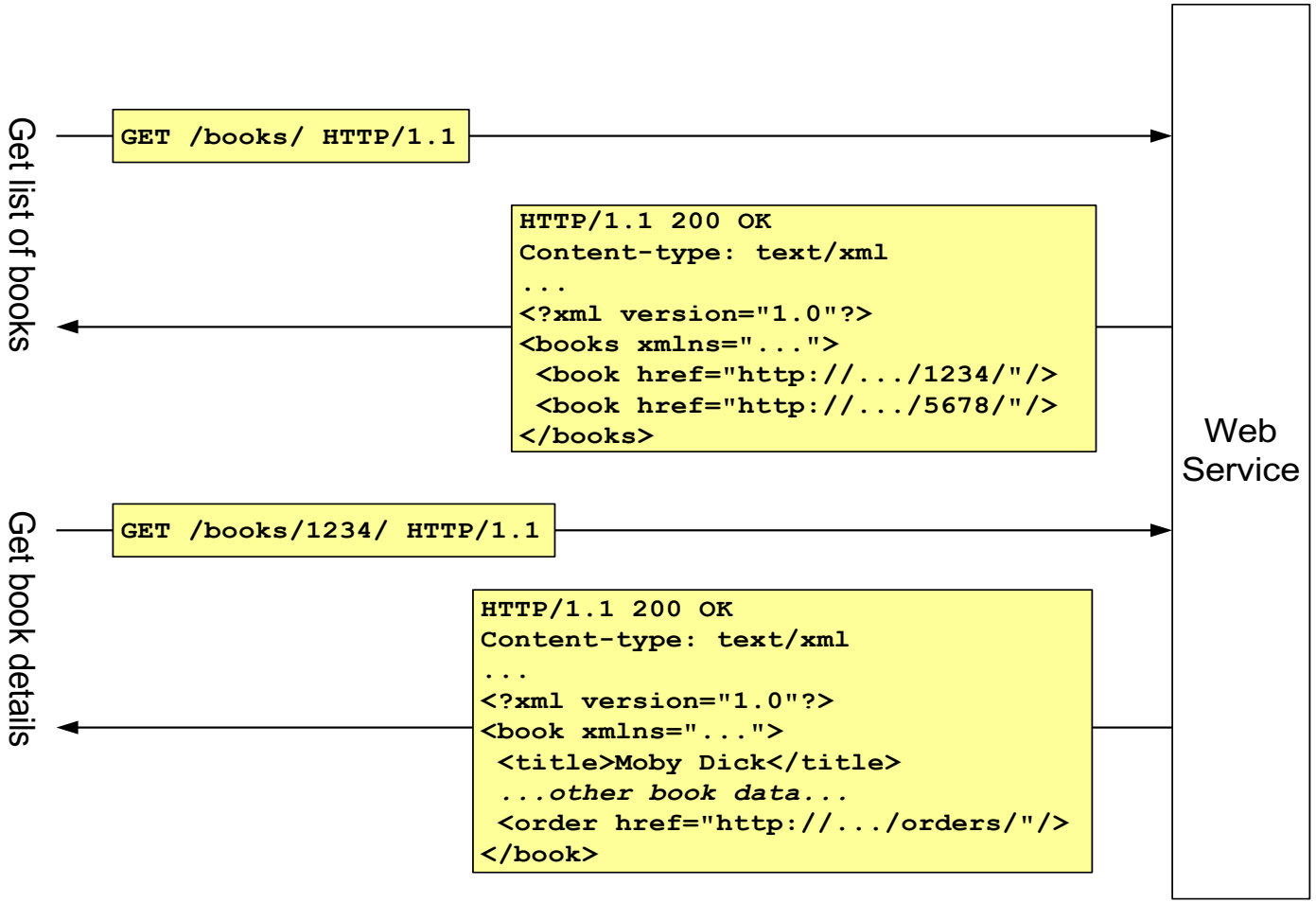
- Much like Web Services, a REST service is:
  - **Platform-independent** (you don't care if the server is Unix, the client is a Mac, or anything else),
  - **Language-independent** (C# can talk to Java, etc.),
  - Standards-based (runs on top of **HTTP**), and
  - Can be used in the presence of **firewalls** (port 80/443 always open)
- Like Web Services, REST offers no built-in security features, encryption, session management, QoS guarantees, etc. But also as with Web Services, these can be added by building on top of HTTP:
  - For security, username/password tokens are often used.
  - For encryption, REST can be used on top of **HTTPS** (secure sockets).
- One thing that is *not* part of a good REST design is cookies:
  - The "ST" in "RE**ST**" stands for "State Transfer", and indeed, in a good REST design operations are self-contained, and each request carries with it (transfers) all the information (state) that the server needs in order to complete it.

REST & the HTML Web

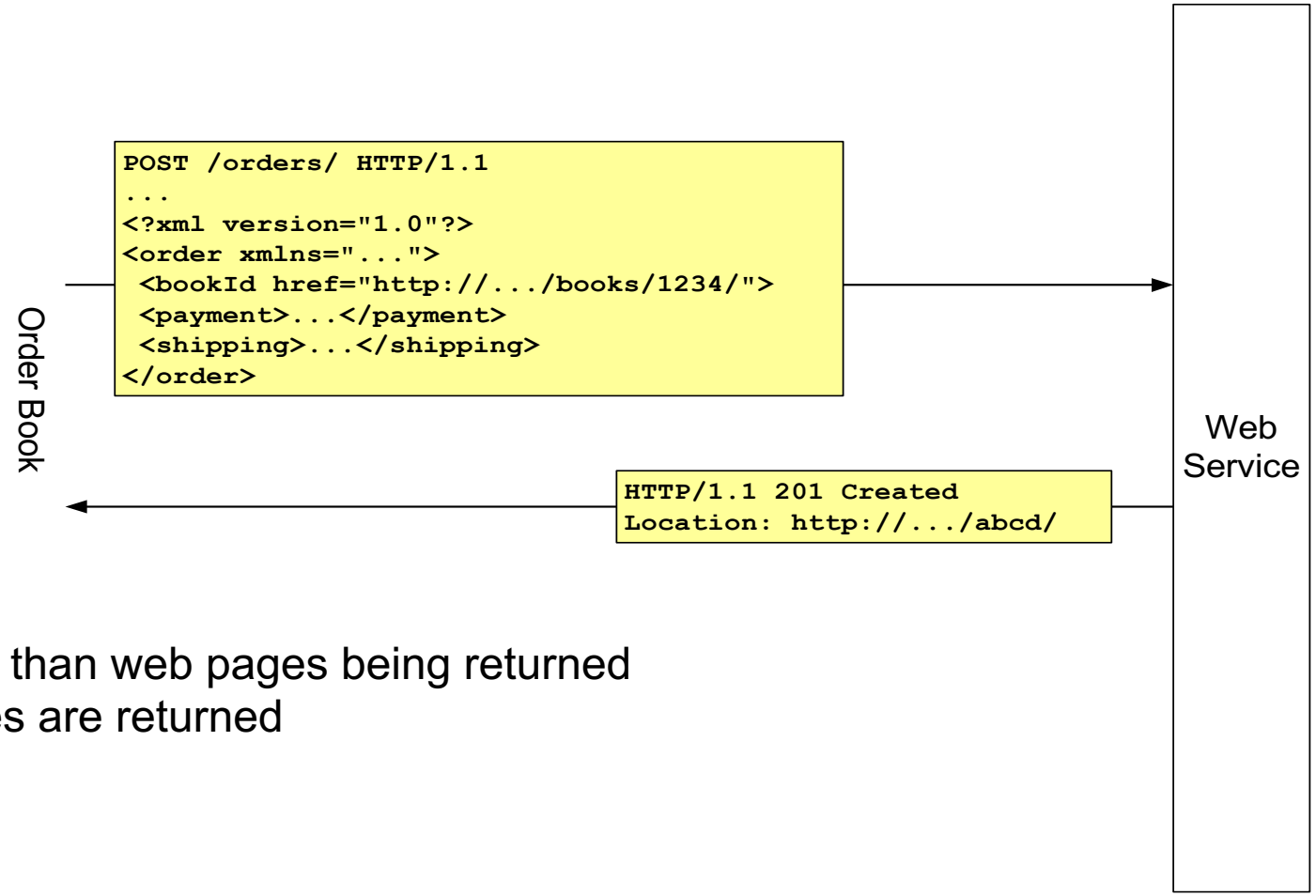
(Get book list, get book details, order book)



REST & the XML Web
(get book list, get book details)



REST & the XML Web (2)
(order book)



Rather than web pages being returned
xml files are returned

REST & the JSON Web
(get book list, get book details)

```
GET /books/ HTTP/1.1

HTTP/1.1 200 OK
Content-type: text/json
{  "books": {
    "book": [
      { "href": "http://.../1234/" },
      { "href": "http://.../5678/" }
  ]
 }
}
```

JSON objects are returned

```
GET /books/1234/ HTTP/1.1

HTTP/1.1 200 OK
Content-type: text/json
{
  "book": {
    "title": "Moby Dick",
    . . . other book data
   "order": { "href": "http://.../orders" }
 }
}
```

REST & the JSON Web (2)
(order book)

```
POST /orders/ HTTP/1.1
{
  "order": {
    "bookId": { "-href": "http://.../books/1234" },
    "payment": " ... ",
    "shipping": " ... ”
 }
}

HTTP/1.1 201 Created
location: http://.../abcd
```

More Complex REST Requests

- REST can easily handle more complex requests, including multiple parameters.
- All types of HTTP requests: **GET, POST, PUT, PATCH, DELETE, COPY, HEAD, OPTIONS, LINK, UNLINK, PURGE**
- In most cases, you'll just use HTTP GET parameters in the URL.
- For example:

```
http://www.acme.com/phonebook/UserDetails?firstName=John&lastName=Doe
```

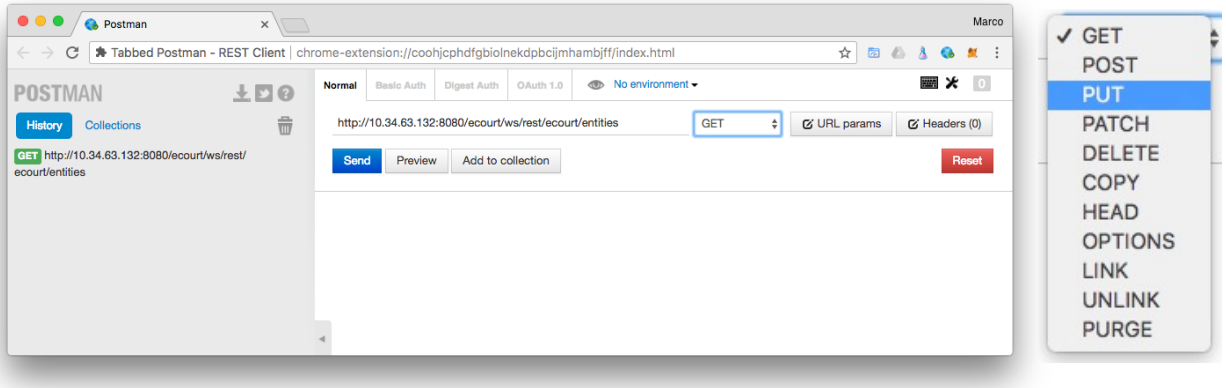
- If you need to pass long parameters, or binary ones, you'd normally use HTTP POST requests, and include the parameters in the POST body.
- As a rule,
  1. **GET** requests should be for read-only queries; they should not change the state of the server and its data.
  2. For creation, updating, and deleting data, use **POST** requests. POST can also be used for read-only queries, as noted above, when complex params are required.'
  3. **PUT**, **DELETE** are also used for updating and deleting items.
- "Legacy" REST services might use XML in their responses.
- Newer REST Services use JSON in their responses.
- **Postman** can be used to test any of the HTTP requests.

Postman

- Postman is a tool for API testing
- Platforms include Chrome add-on, MacOS, Windows and Linux native apps
- Download page available at:

  `https://www.getpostman.com/apps`

- Free version comes with the following support:
  - Unlimited Postman collections, variables, environments, & collection runs
  - Postman Workspaces
  - Postman Help Center & Community Support
  - API Documentation (1000 Monthly document views)
  - Mock Servers (1000 Monthly mock server calls)
  - Postman API (1000 Monthly API calls)
  - API Monitoring (100 Monthly calls)
- Postman Pro and Postman Enterprise provide additional feature on a monthly subscription.



REST Server Responses

- A server response in REST used to be an XML file; for example,

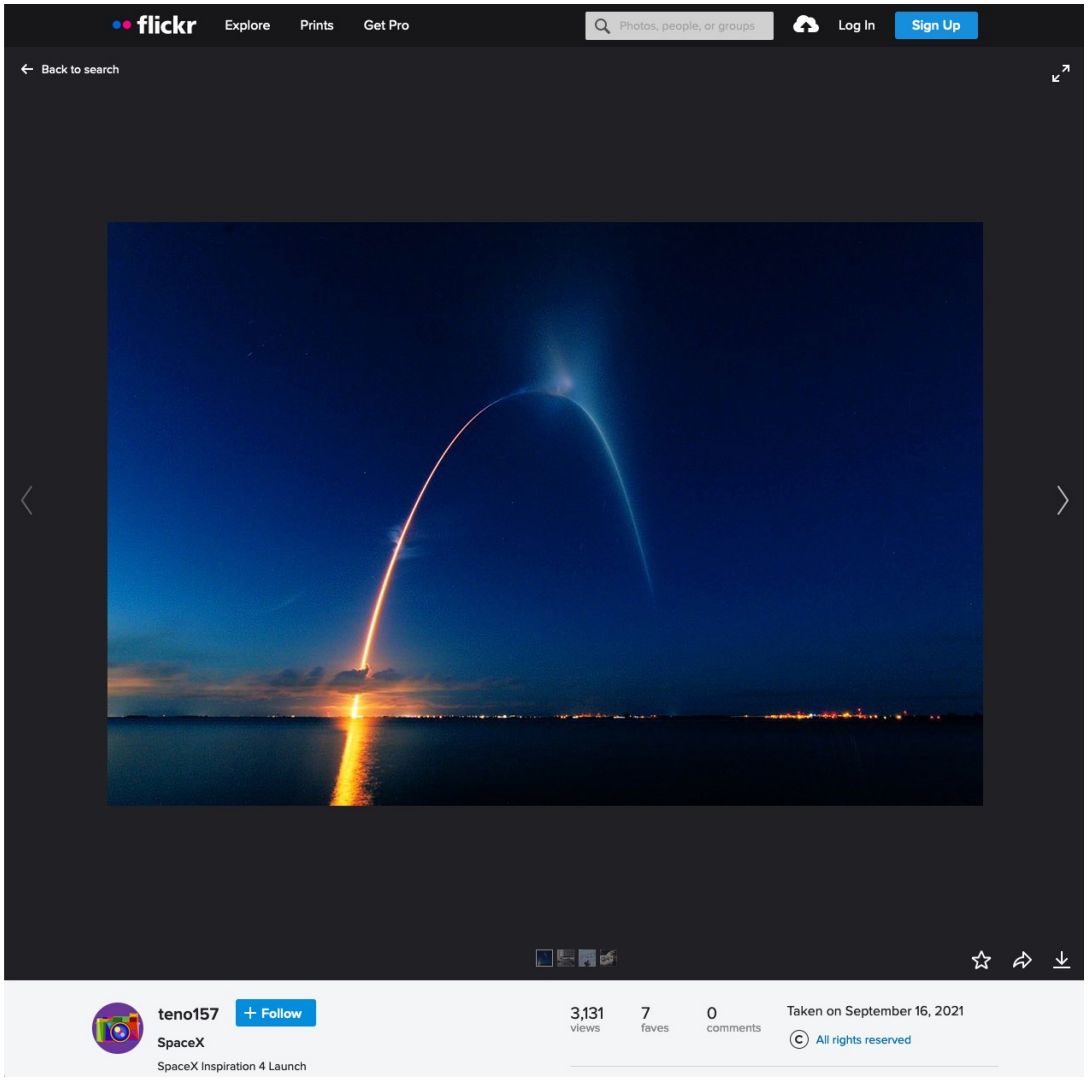
```
<parts-list>
  <part id="3322">
    <name>ACME Boomerang</name>
    <desc> Used by Coyote in <i>Zoom at the Top</i>, 1962 </desc>
    <price currency="usd" quantity="1">17.32</price>
    <uri>http://www.acme.com/parts/3322</uri> </part>
  <part id="783">
    <name>ACME Dehydrated Boulders</name>
    <desc> Used by Coyote in <i>Scrambled Aches</i>, 1957 </desc>
    <price currency="usd" quantity="pack">19.95</price>
    <uri>http://www.acme.com/parts/783</uri>
</part> </parts-list>
```

- However, other formats can also be used; REST is *not* bound to XML in any way. JSON is the response format recently used the most. Possible formats include CSV.
- One option that is *not* acceptable as a REST response format, except in very specific cases is HTML, or any other format which is meant for human consumption and is not easily processed by clients.
- The specific exception is, of course, when the REST service is documented to return a human-readable document; and when viewing the entire WWW as a RESTful application, we find that HTML is in fact the most common REST response format.

Flickr

- Photo-sharing community with APIs provide viewing and uploading access
- See: https://www.flickr.com/services/api/
- **Request formats**: REST, XML-RCP, SOAP
- **Response Formats**: REST, XML-RPC, SOAP, JSON, PHP. Supports JSONP.
- API Developer Kits available for 15 languages including ActionScript (Flash), Java (Android), .NET, Objective-C (iOS)
- Comprehensive number of API methods for authentication, blogs, contacts, favorites, galleries, people, photos
- Example Query:
  - https://api.flickr.com/services/rest/?method=flickr.photos.getRecent&api_key=f2cc26448280a762143ba4a865795ab4&format=json
  - (remove format parameter for XML results)
  - **https** required since June 2014

Flickr



Flickr Sample JSON Result

jsonFlickrApi({"photos":{"page":1, "pages":10, "perpage":100, "total":1000, "photo":[{"id":"6879393174", "owner":"50010354@N05", "secret":"cf784500dd", "server":"7080", "farm":8, "title":"wjk_20110611_0092.jpg", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393274", "owner":"31403543@N03", "secret":"af280ab218", "server":"6231", "farm":7, "title":"Imagen 415", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393306", "owner":"66286618@N05", "secret":"7fc731bc3d", "server":"6237", "farm":7, "title":"IMG_6241-1", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393338", "owner":"28935680@N03", "secret":"ec7444d9b6", "server":"7237", "farm":8, "title":"IMG_6756", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393352", "owner":"32752988@N06", "secret":"be56f5751c", "server":"6046", "farm":7, "title":"AED_4586", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393370", "owner":"29083790@N00", "secret":"ec89570135", "server":"6219", "farm":7, "title":"IMG_6546", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393402", "owner":"50702313@N08", "secret":"18ecdd7871", "server":"7191", "farm":8, "title":"Group A 3", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393418", "owner":"8502118@N08", "secret":"082968f6a9", "server":"6220", "farm":7, "title":"Buff-necked Ibis (Theristicus caudatus)", "ispublic":1, "isfriend":0, "isfamily":0}, {"id":"6879393440", "owner":"51425572@N04", "secret":"bc5f816ffb", "server":"6219", "farm":7, "title":"P2115768", "ispublic":1, "isfriend":0, "isfamily":0}, […]})

Partial Flickr Sample JSON Result With Formatting

jsonFlickrApi({"photos":{"page":1, "pages":10, "perpage":100, "total":1000,
"photo":[
{"id":"6879682760", "owner":"8348059@N02", "secret":"1ac6c7e2c4", "server":"6220", "farm":7,
"title":"DSC_0619", "ispublic":1, "isfriend":0, "isfamily":0},
{"id":"6879682762", "owner":"35772789@N02", "secret":"db5dffb91d", "server":"6117", "farm":7,
"title":"Dianna Romo 5", "ispublic":1, "isfriend":0, "isfamily":0},
{"id":"6879682776", "owner":"8091633@N05", "secret":"302174b53e", "server":"6118", "farm":7,
"title":"DSC_4259", "ispublic":1, "isfriend":0, "isfamily":0},
{"id":"6879682778", "owner":"58641881@N08", "secret":"c028082788", "server":"7212", "farm":8,
"title":"DSC_0777", "ispublic":1, "isfriend":0, "isfamily":0},
{"id":"6879682790", "owner":"32045507@N06", "secret":"d80d372bd2", "server":"6093", "farm":7,
"title":"IMG_9136", "ispublic":1, "isfriend":0, "isfamily":0},
{"id":"6879682792", "owner":"76919580@N08", "secret":"57e8d1cf8d", "server":"7277", "farm":8,
"title":"DSC01410", "ispublic":1, "isfriend":0, "isfamily":0},
{"id":"6879682796", "owner":"50838701@N04", "secret":"a3431e27e9", "server":"6042", "farm":7,
"title":"eP3274587", "ispublic":1, "isfriend":0, "isfamily":0},

Microsoft Bing Maps REST Services

- Bing Maps REST Services: https://docs.microsoft.com/en-us/bingmaps/rest-services/
- The Bing Spatial Data Services are REST-based services that offer three key functionalities: batch geocoding, point of interest (POI) data, and the ability to store and expose your spatial data.
- Used for performing tasks such as geocoding, reverse-geocoding, routing and static imagery.
- REST Request URLs:

- Find a location by **Address**:

http://dev.virtualearth.net/REST/v1/Locations/CA/adminDistrict/postalCode/locality/addressLine?includeNeighborhood=includeNeighborhood&maxResults=maxResults&key=BingMapsKey

- Find a location by **Query**:

http://dev.virtualearth.net/REST/v1/Locations/1%20Microsoft%20Way%20Redmond%20WA%2098052?o=xml&key=BingMapsKey

- Find a location by **Point**:

http://dev.virtualearth.net/REST/v1/Elevation/List?points=35.89431,-110.72522,35.89393,-110.72578,35.89374,-110.72606,35.89337,-110.72662&key=BingMapsKey

Microsoft REST Services (cont'd)

- Request Parameters: See complete list at:

https://docs.microsoft.com/en-us/bingmaps/rest-services/common-parameters-and-types

– **Response formats**: XML, JSON (output=JSON), JSONP (jsonp=callback), and PHP

- Response fields (Location Data) defined at:

https://docs.microsoft.com/en-us/bingmaps/rest-services/common-response-description

Amazon Web Services

- Among them are
  - Amazon Associates Web Services (see next slides)
  - Amazon Elastic Compute Cloud (or EC2)
    - allows users to rent computers on which to run their own computer applications. EC2 allows scalable deployment of applications by providing a web service through which a user can boot an Amazon Machine Image to create a virtual machine, which Amazon calls an "instance", containing any software desired.
    - A user can create, launch, and terminate server instances as needed, paying by the hour for active servers, hence the term "elastic".
  - Amazon primarily charges customers in two ways:
    - On-demand pricing. Example: EC2 Linux, t2.nano $0.0058 per hour

    https://aws.amazon.com/ec2/pricing/on-demand/
    - Spot Instances pricing. Example: linux, m4.large $0.019 per Hour

    https://aws.amazon.com/ec2/spot/pricing/
    - Reserved Instances pricing.

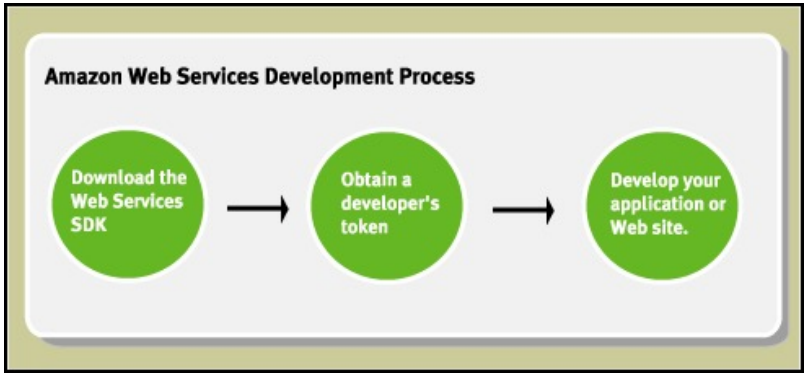
    https://aws.amazon.com/ec2/pricing/reserved-instances/pricing/
    - Dedicated Hosts pricing.

    https://aws.amazon.com/ec2/dedicated-hosts/pricing/

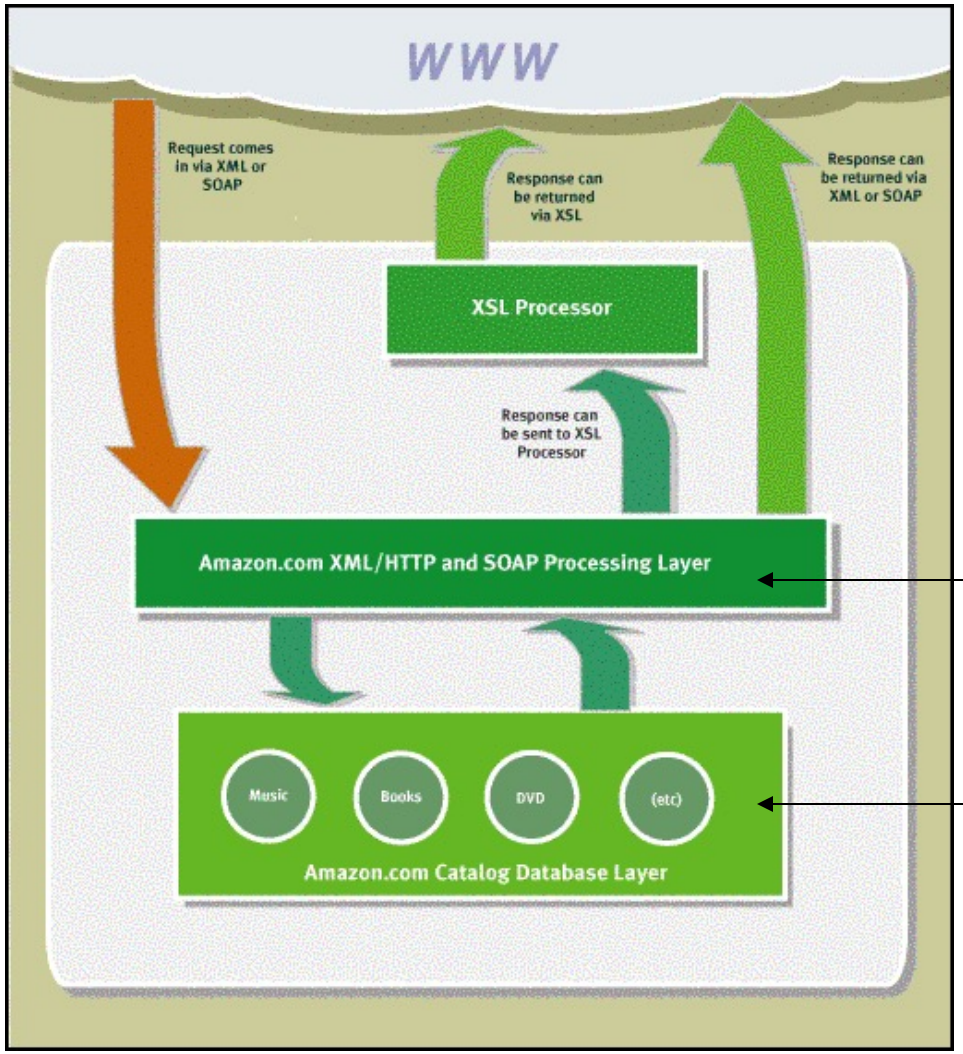
  - See http://en.wikipedia.org/wiki/Amazon_Elastic_Compute_Cloud for details

Amazon Associates Web Services

- Amazon offers web services to 3 types of users:
  - **Associates**: third-party site owners wishing to build more effective sponsored affiliate links to Amazon products, thus increasing their referral fees
  - **Vendors**: sellers on the Amazon platform looking to manage inventory and receive batch product data feeds
  - **Developers**: third-party developers building Amazon-driven functionality into their applications
- Amazon Web Services provides software developers direct access to Amazon's technology platform and product data.
- Developers can build businesses by creating Web sites and Web applications that use Amazon products, charging and delivery mechanisms.
- Using Web services, you can now enable your Web site visitors to add products to Amazon.com shopping carts, wedding registries, baby registries and wish lists directly from your site.
- http://aws.amazon.com/



Amazon Associates Web Services Data Flow



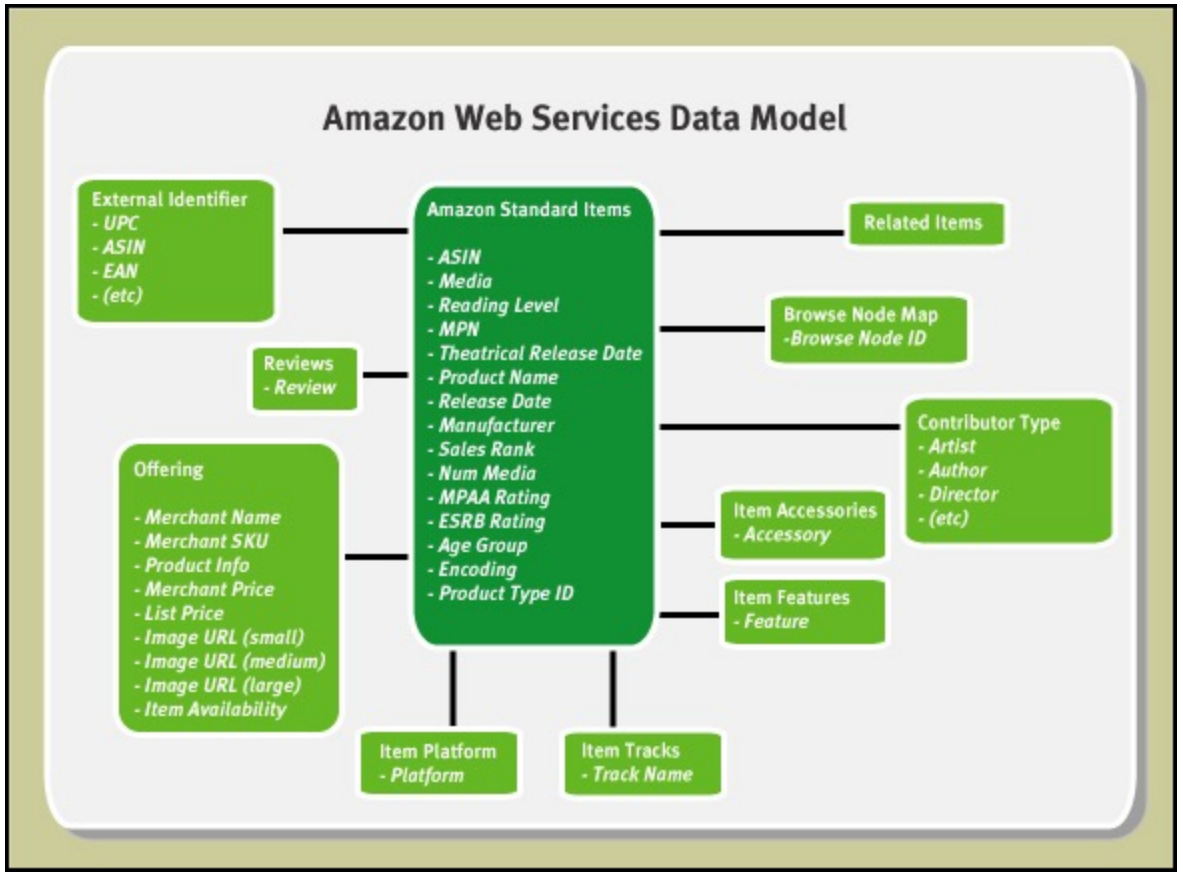
Amazon results can be returned either as XML files or as SOAP messages

XML/HTTP stands for REST

Data

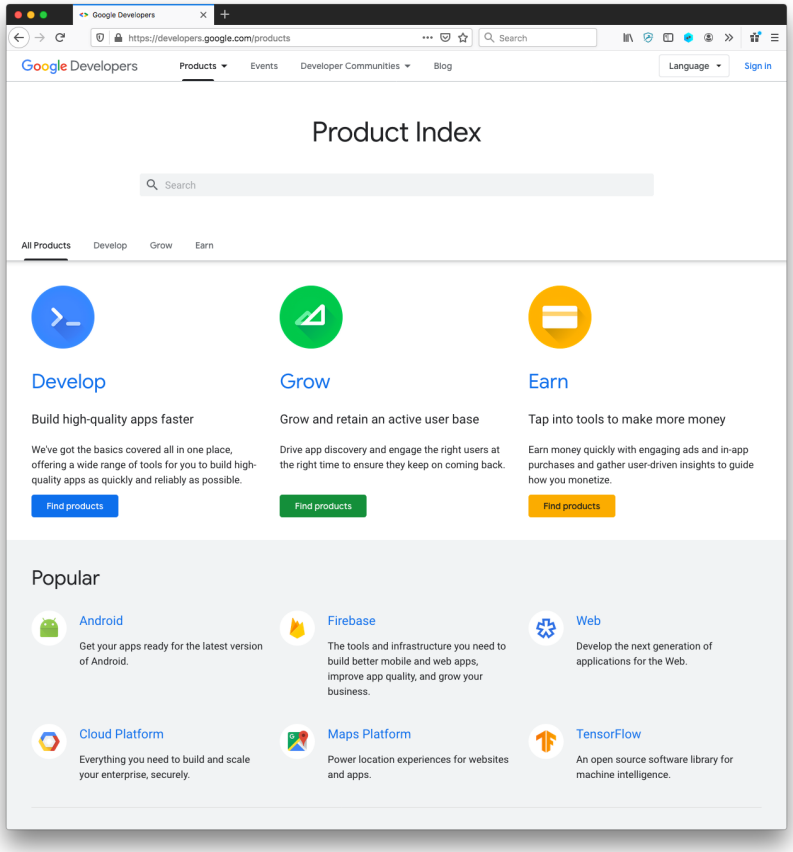
Amazon Web Services Data Model

Below is a graphical listing of the elements of the *A*mazon *W*eb *S*ervices data model.
The graphic represents the logical structure of AWS data.



Google APIs

- Available at:
  - http://developers.google.com/products
- APIs available for:
  - Android
  - App Engine
  - Chrome
  - Games
  - Google Maps
  - Google Apps
  - Google Play
  - Commerce
  - YouTube
  - Etc.
- **Develop**, **Grow**, and **Earn**



Google App Engine

- Google App Engine lets you run Web Applications / Web Services on GCP.
  - There are no servers to maintain: You just upload your application (like AWS)
- You can serve your app from your own domain name, or you can serve your app using a free name on the appspot.com domain.
  - You can limit access to members of your organization.
- Google App Engine supports apps written in several programming languages
  1. **Java** environment, including the JVM, and Java servlets.
  2. **PHP**
  3. **Python**. App Engine also features two dedicated **Python** runtime environments, each of which includes a fast Python interpreter and the Python standard library.
  4. **Go**. App Engine provides a **Go** runtime that runs natively compiled Go code.
  5. **Node.js** & **Ruby**.
  6. **Custom Runtimes**. Included in the "flexible environment".
- Download App Engine SDKs at:

  https://cloud.google.com/appengine/downloads
- You only pay for what you use and there are no set-up costs and no recurring fees
- Free daily limits are quite high: **860K API calls (URLFetch API) ,** 200h connect time, 5GB storage) See: https://cloud.google.com/appengine/quotas

Google App Engine Free Quota

- See: https://cloud.google.com/appengine/quotas

Resource	Free Default Limit	Billing Enabled Default Limit
Default Google Cloud Storage Bucket Stored Data	5 GB	First 5 GB free; no maximum
Default Google Cloud Storage Bucket Class A Operations	20,000 ops/day	First 20,000 ops/day free; no maximum
Default Google Cloud Storage Bucket Class B Operations	50,000 ops/day	First 50,000 ops/day free; no maximum
Default Google Cloud Storage Bucket Network Egress	Up to the Outgoing Bandwidth quota	Up to the Outgoing Bandwidth quota free; no maximum

Resource	Free Default Limit		Billing Enabled Default Limit	
	Daily Limit	Maximum Rate	Daily Limit	Maximum Rate
Channel API Calls	657,000 calls	3,000 calls/minute	91,995,495 calls	32,000 calls/minute
Channels Created	100 channels	6 creations/minute	Based on your spending limit	60 creations/minute
Channel Hours Requested	200 hours	12 hours requested/minute	Based on your spending limit	180 hours requested/minute
Channel Data Sent	Up to the Outgoing Bandwidth quota	22 MB/minute	1 TB	740 MB/minute

Resource	Cost
Code & Static Data Storage - First 1 GB	Free
Code & Static Data Storage - Exceeding 1 GB	$0.026/GB/month

Resource	Free Default Daily Limit	Billing Enabled Default Limit
Stored Data (billable)	1 GB *	1 GB free; no maximum
Number of Indexes	200 *	200
Entity Reads	50,000	$0.06/100k entity read
Entity Writes	20,000	$0.18/100k entity writes
Entity Deletes	20,000	$0.02/100k entity deletes
Small Operations	Unlimited	Not applicable

Programmable Search Engine

- Previously known as “Google Custom Search.”
- Enables searching over a website or a collection of websites
- Places a Google search box on a website that allows users to search the site
- Search results can be customized to match the design of the site
  - Google form to be filled out to create the custom search box

  http://cse.google.com/
- Create a “**Programmable search engine**”
  - Google Custom Search enables you to create a search engine for your website, your blog, or a collection of websites. You can configure your engine to search both web pages and images
- Search experience for users
  - Site search for your website
  - Topical search engine
  - Use structured data with Custom Search
- See: https://developers.google.com/custom-search/
- Documentation on implementing a “search box”: https://developers.google.com/custom-search/docs/tutorial/implementingsearchbox

Google API Example: Google Maps API

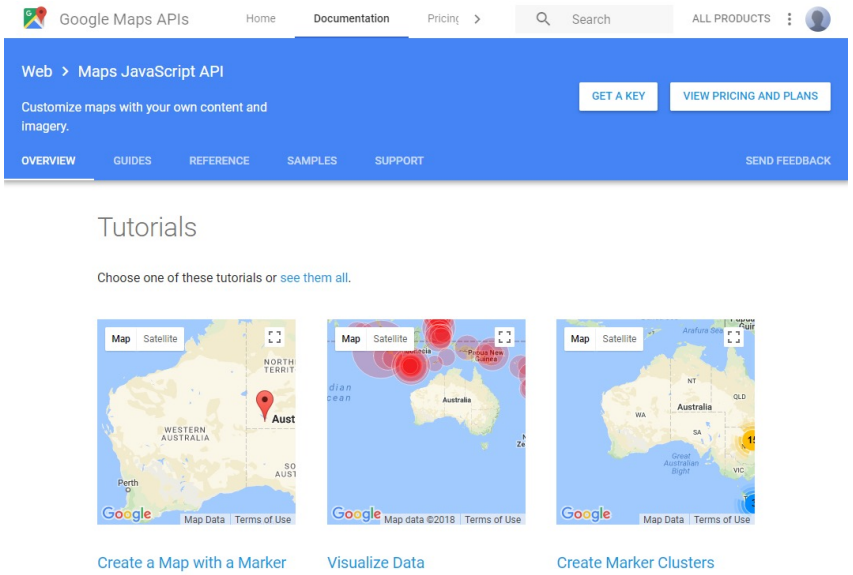
- We will use the JavaScript API for Google maps

  `https://developers.google.com/maps/documentation/javascript`
- We will use their API, V. 3, click on "Get Started"
- First step: obtain an API key by click on “GET A KEY”
- Second step: return to

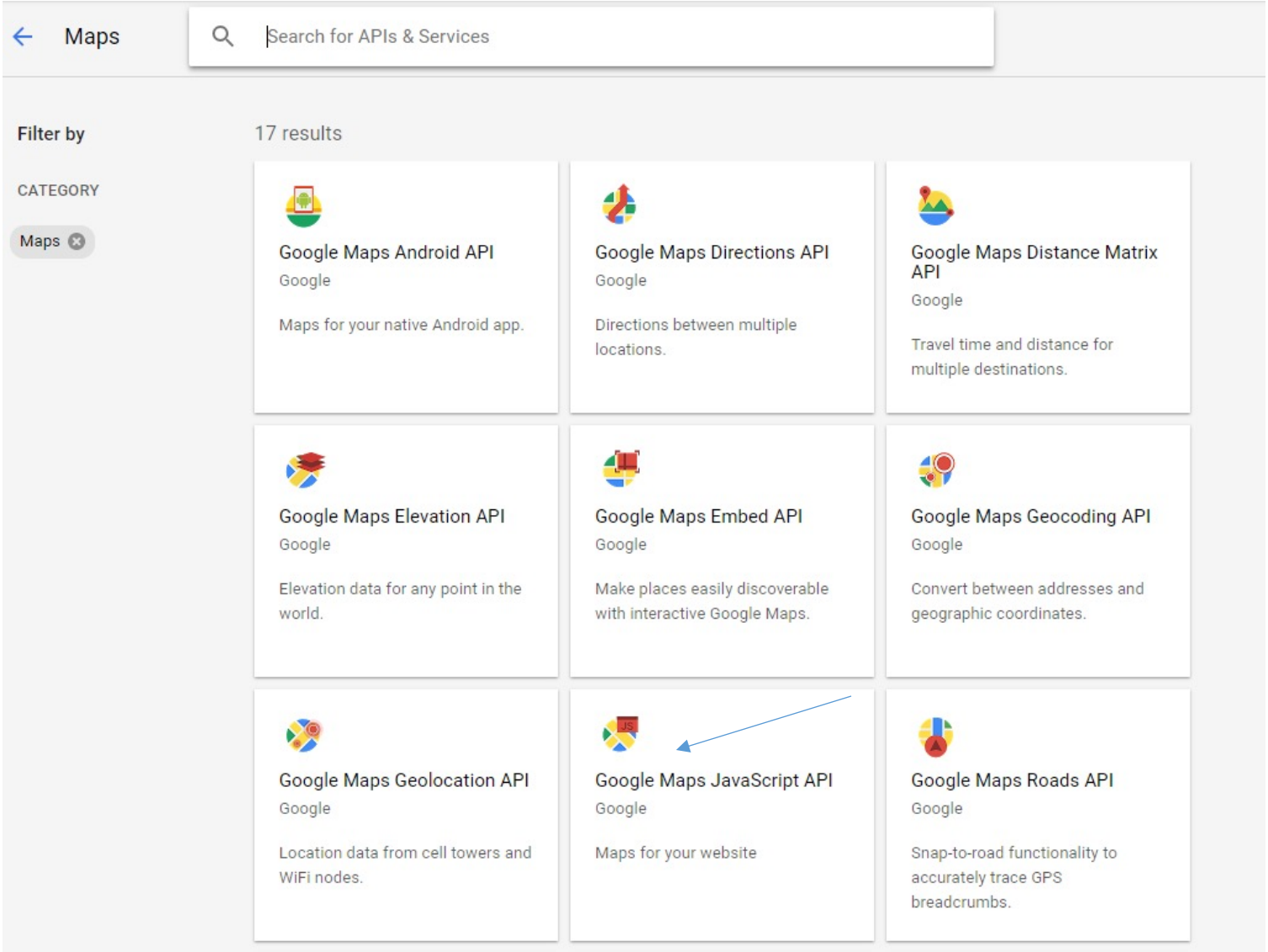
  `https://developers.google.com/maps/documentation/javascript/tutorial`

and examine the sample code

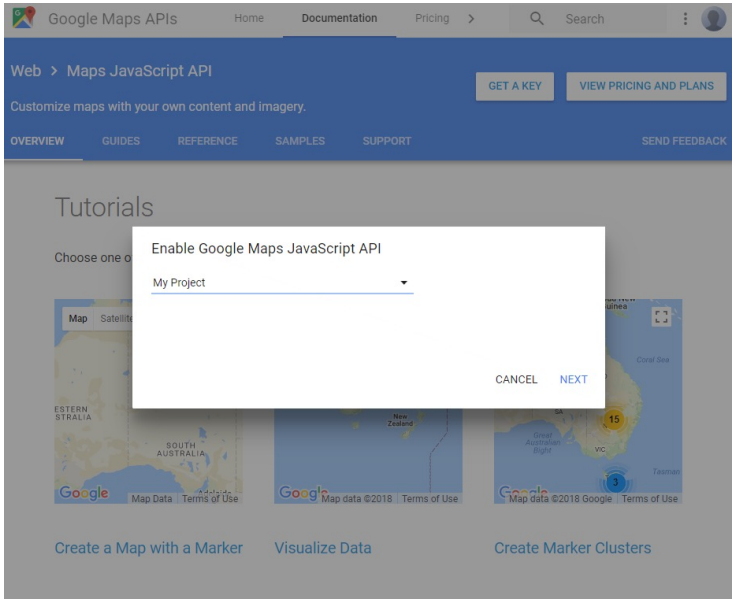
Note: Google Maps API material not required. Skip to Slide 42, Apple iCloud for developers.



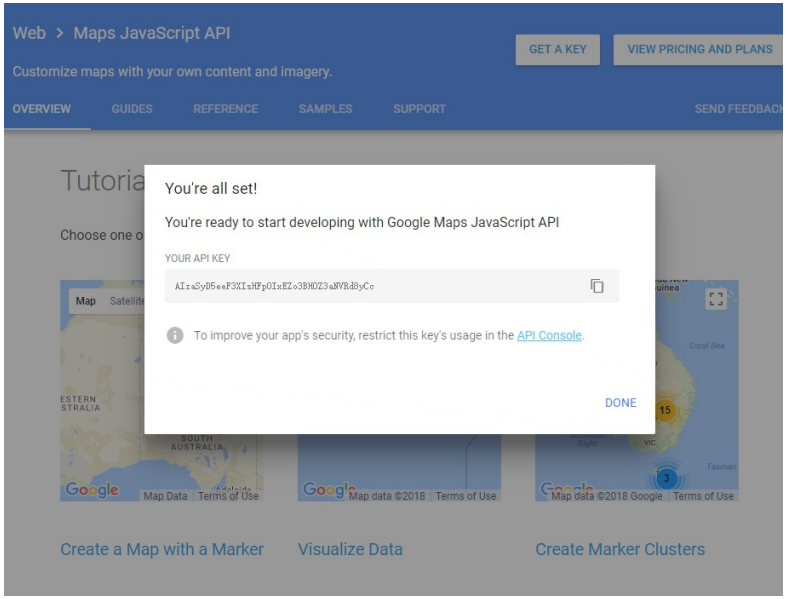
Activate Google Maps JavaScript API v3



Obtaining an API Key



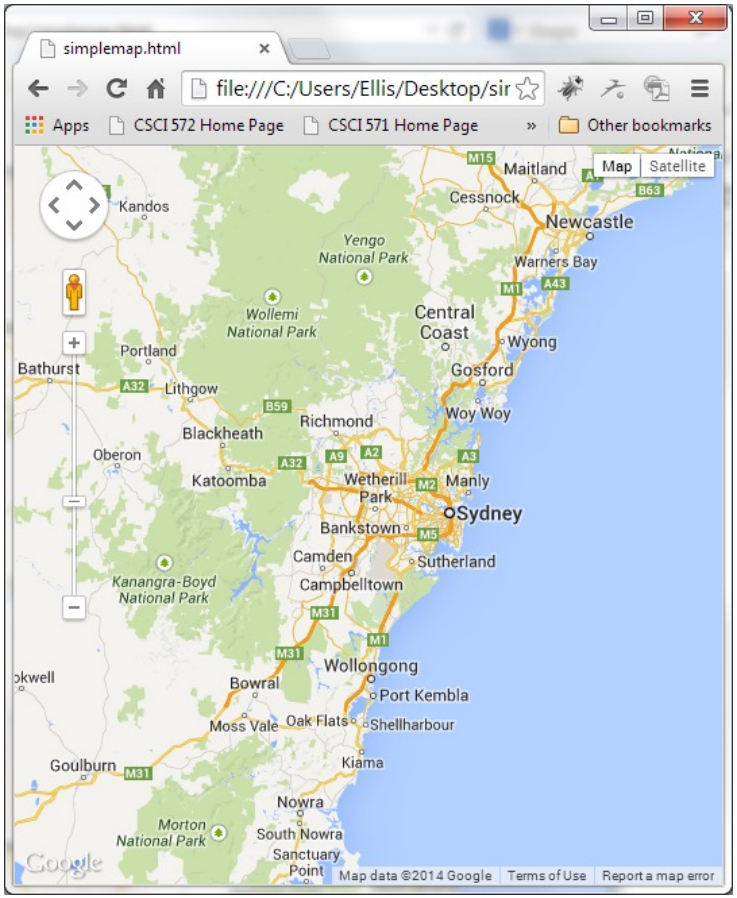
Select Project



Returning a key result

Simple Maps Example

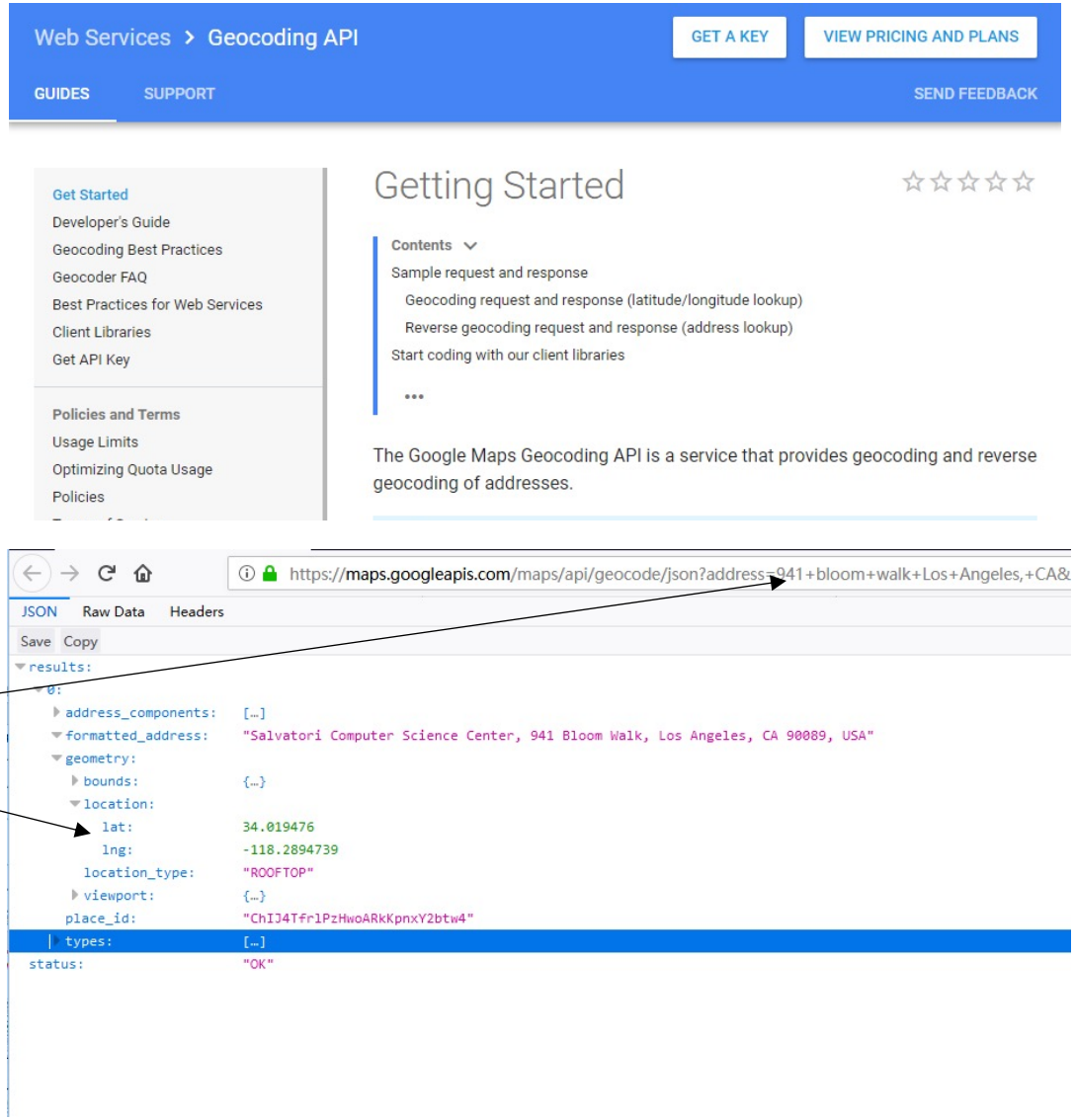
```
<!DOCTYPE html>

<html><head><meta name="viewport" content="initial-
scale=1.0, user-scalable=no" />

    <style type="text/css">

      html { height: 100% }

      body { height: 100%; margin: 0; padding: 0 }

      #map-canvas { height: 100% }

    </style>

    <script type="text/javascript"

src="https://maps.googleapis.com/maps/api/js?key=API_KEY"
>

    </script>

    <script type="text/javascript">

      function initialize() {

        var mapOptions = {

          center: new google.maps.LatLng(-34.397,
150.644),

          zoom: 8    };

        var map = new
google.maps.Map(document.getElementById("map-canvas"),

            mapOptions);     }

      google.maps.event.addDomListener(window, 'load',
initialize);</script></head>

<body> <div id="map-canvas"/></body></html>
```



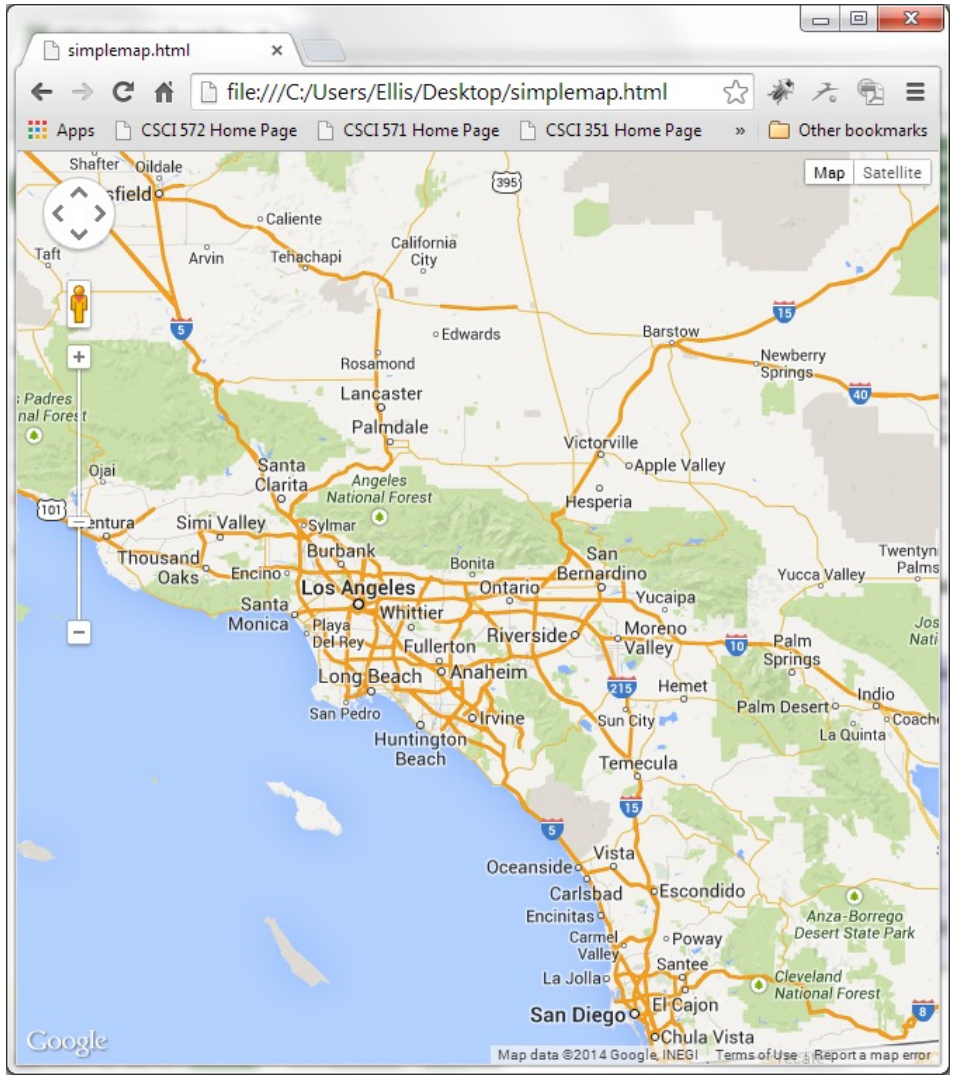
for many more details about this example see https://developers.google.com/maps/documentation/javascript/tutorial

Changing the Map's Center Point

- Use Geocoding API to find the latitude/longitude of a local address
- Use a geocoding service at: https://developers.google.com/maps/documentation/geocoding/start
- For an address we will use the CS dept
- The result is the lat/long

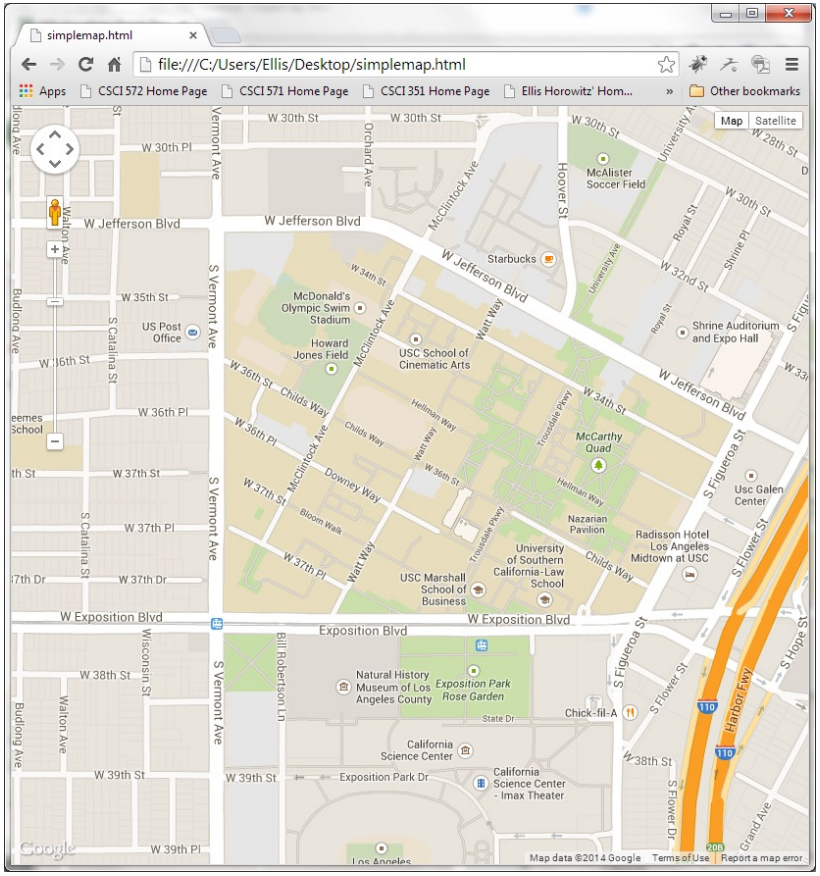


Simple Map with Lat/Long Change



Changing the Zoom Level

- the zoom level controls the distance above the map
- higher values cause the zoom to close in
- set the zoom value to 16 and the resulting map is produced



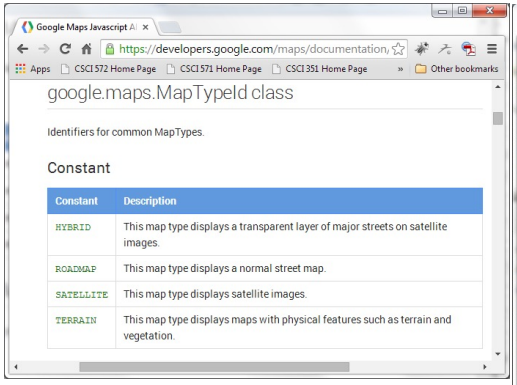
ROADMAP

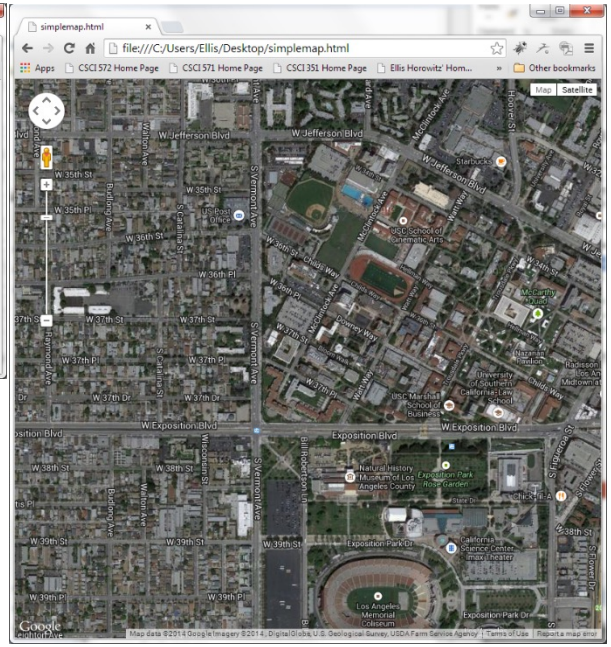
Adding a Marker to the Map

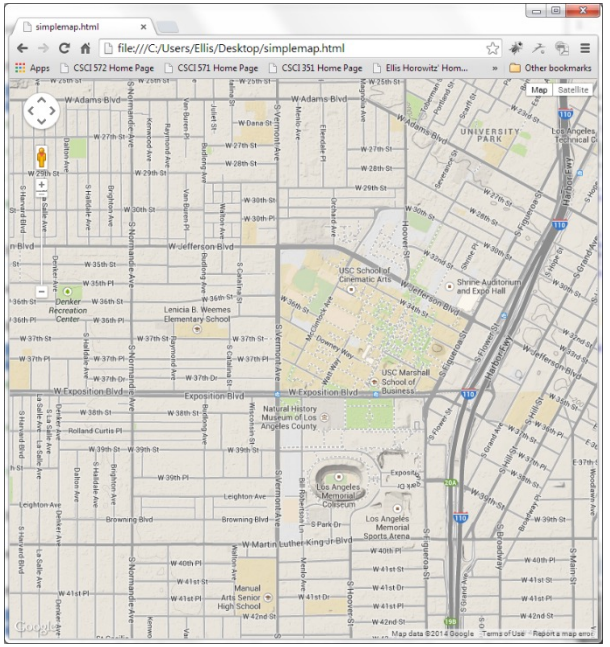
- But where is the CS dept.? we need to add a marker
- we see an example of a marker at https://developers.google.com/maps/documentation/javascript/examples/marker-simple

```
function initialize() {
  var myLatLng = {lat: 34.020, lng: -118.290};
  var mapOptions = {  zoom: 4,  center: myLatlng  }
  var map = new google.maps.Map(document.getElementById('map-
canvas'), mapOptions);
  var marker = new google.maps.Marker({
      position: myLatlng,
      map: map,
      title: 'CS Dept'
  });
}
google.maps.event.addDomListener(window, 'load', initialize);
```

Change the Map Type





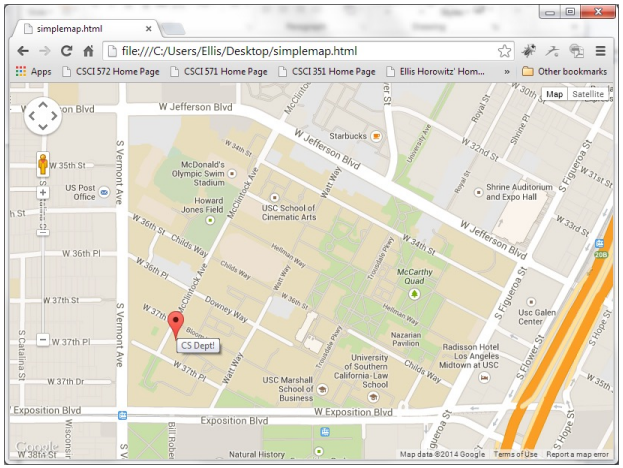


there are 4 map types:
HYBRID
ROADMAP
SATELLITE
TERRAIN

one can alter the map type by adding the line:
mapTypeId: 'satellite'; or
map.setMapTypeId('terrain');

Add a Marker with Tool Tip

```
<!DOCTYPE html>

<html><head><meta name="viewport" content="initial-scale=1.0,
user-scalable=no" />

    <style type="text/css">

      html { height: 100% } body { height: 100%; margin: 0;
padding: 0 }

      #map-canvas { height: 100% }

    </style>  <script type="text/javascript"

src="https://maps.googleapis.com/maps/api/js?key=AIzaSyC0CF4Fh0OQs
redZjT8LAl6yvZ7Ux9dnuQ">

    </script>

    <script type="text/javascript">

function initialize() {

var mapOptions = {center: new google.maps.LatLng(34.020, -
118.290),

          zoom: 16   };

var map = new google.maps.Map(document.getElementById("map-
canvas"), mapOptions);

        var marker = new google.maps.Marker({

           position: new google.maps.LatLng(34.020, -118.290),

           map: map,

           title: 'CS Dept!'  })     }

  google.maps.event.addDomListener(window, 'load',
initialize);</script></head>

  <body> <div id="map-canvas"/></body></html>
```

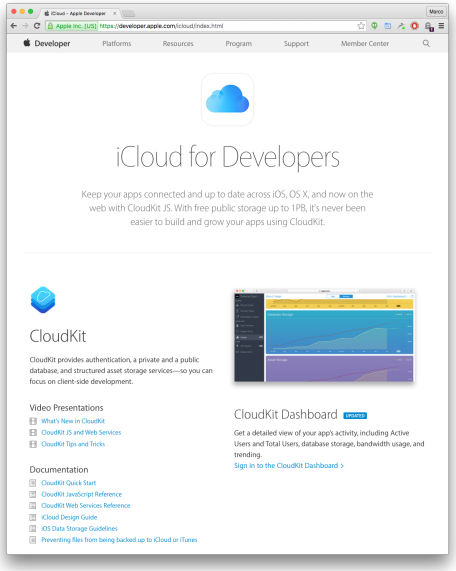


Adding a Popup Info Window to the Marker

```
<!DOCTYPE html><html><head><meta name="viewport" content="initial-
scale=1.0, user-scalable=no" />
    <style type="text/css">
html { height: 100% } body { height: 100%; margin: 0; padding: 0 }
#map-canvas { height: 100% }
    </style><script type="text/javascript"
src="https://maps.googleapis.com/maps/api/js?key=AIzaSyC0CF4Fh0OQsredZjT8LA
l6yvZ7Ux9dnuQ">
    </script><script type="text/javascript">
function initialize() {
var mapOptions = {
center: new google.maps.LatLng(34.020, -118.290),zoom: 16   };
var map = new google.maps.Map(document.getElementById("map-canvas"),
mapOptions);
var marker = new google.maps.Marker({
           'position': new google.maps.LatLng(34.020, -118.290),
'map': map, 'title': 'CS Dept!'})}
 var contentString = '<div id="content">'+
 '<div id="siteNotice">CS Dept</div></div>';
var infowindow = new google.maps.InfoWindow({ content: contentString });
     google.maps.event.addDomListener(window, 'load', initialize);
     google.maps.event.addListener(marker, 'click', function() {
infowindow.open(map, marker) } );
</script></head><body> <div id="map-canvas"/></body></html>
```

Apple iCloud For Developers

- Apple's iCloud service places all information captured on any Apple device into the cloud, making it immediately available to all other Apple devices
- 5GB (free) – 50GB, 200GB, 1TB plans available at:
  - http://www.apple.com/icloud/
  - https://developer.apple.com/icloud/index.html
- iCloud APIs available for iOS 5 through 13 and OS X 10.9+
  - CloudKit framework
  - Storage API for Documents
  - Storage API for key-value data storage
  - Storage API for Core Data
  - Fallback Store (iOS 7+)
  - Account Changes (iOS 7+)
  - Manage iCloud Content (iOS 7+)
  - Xcode debugging (Xcode 5+)
  - iPhone simulator support (iOS 7+)



REST Best Practices

- 1. Provide a **URI for each resource** that you want exposed.
- 2. Prefer URIs that are logical over URIs that are physical. For example, prefer

http://www.boeing.com/airplanes/747

Over:

http://www.boeing.com/airplanes/747.html

- Logical URIs allow the resource implementation to change without impacting client applications
- 3. As a corollary to (2) **use nouns in the logical URI, not verbs**. Resources are "things“ not "actions"
- 4. Make all HTTP GETs side-effect free.
- 5. Use links in your responses to requests. Doing so connects your response with other data. It enables client applications to be self-propelled. That is, the response itself contains info about "what's the next step to take".
- 6. **Minimize the use of query strings**. For example, prefer

http://www.parts-depot.com/parts/00345

Over

http://www.parts-depot.com/parts?part-id=00345

- 7. Use the slash "/" to represent a parent-child, whole-part relationship
- 8. Use a "gradual unfolding methodology" for exposing data to clients. That is, a resource representation should provide links to obtain more details.
- 9. Always implement a service **using HTTP GET** when the purpose of the service is to allow a client to **retrieve a resource representation**, i.e., don’t use HTTP POST