AJAX

SWE 432, Fall 2016

Design and Implementation of Software for the Web

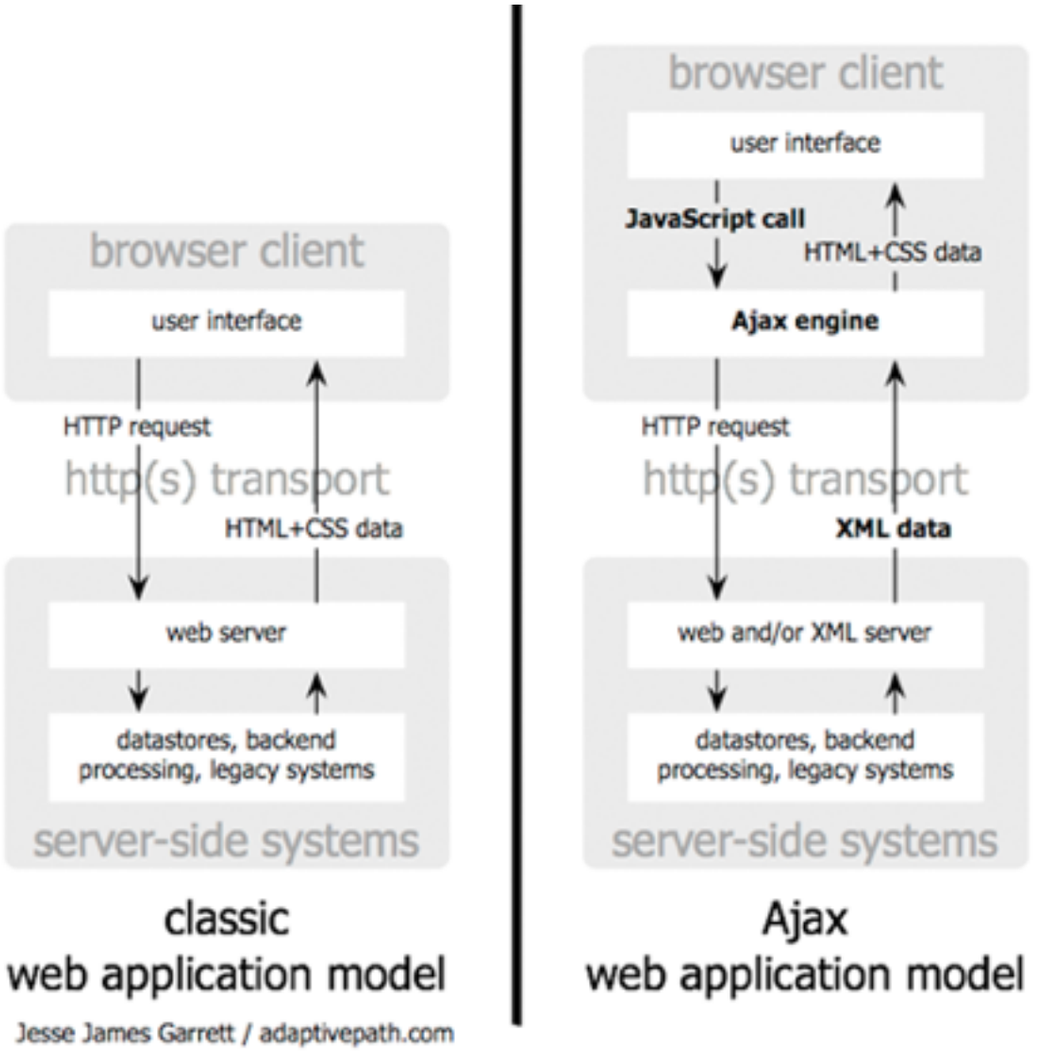
GEORGE MASON UNIVERSITY

Today's Objectives

- Learn how to interact with remote hosts from a web page using AJAX
- Learn how to use Firebase web service to persist and synchronize data in realtime

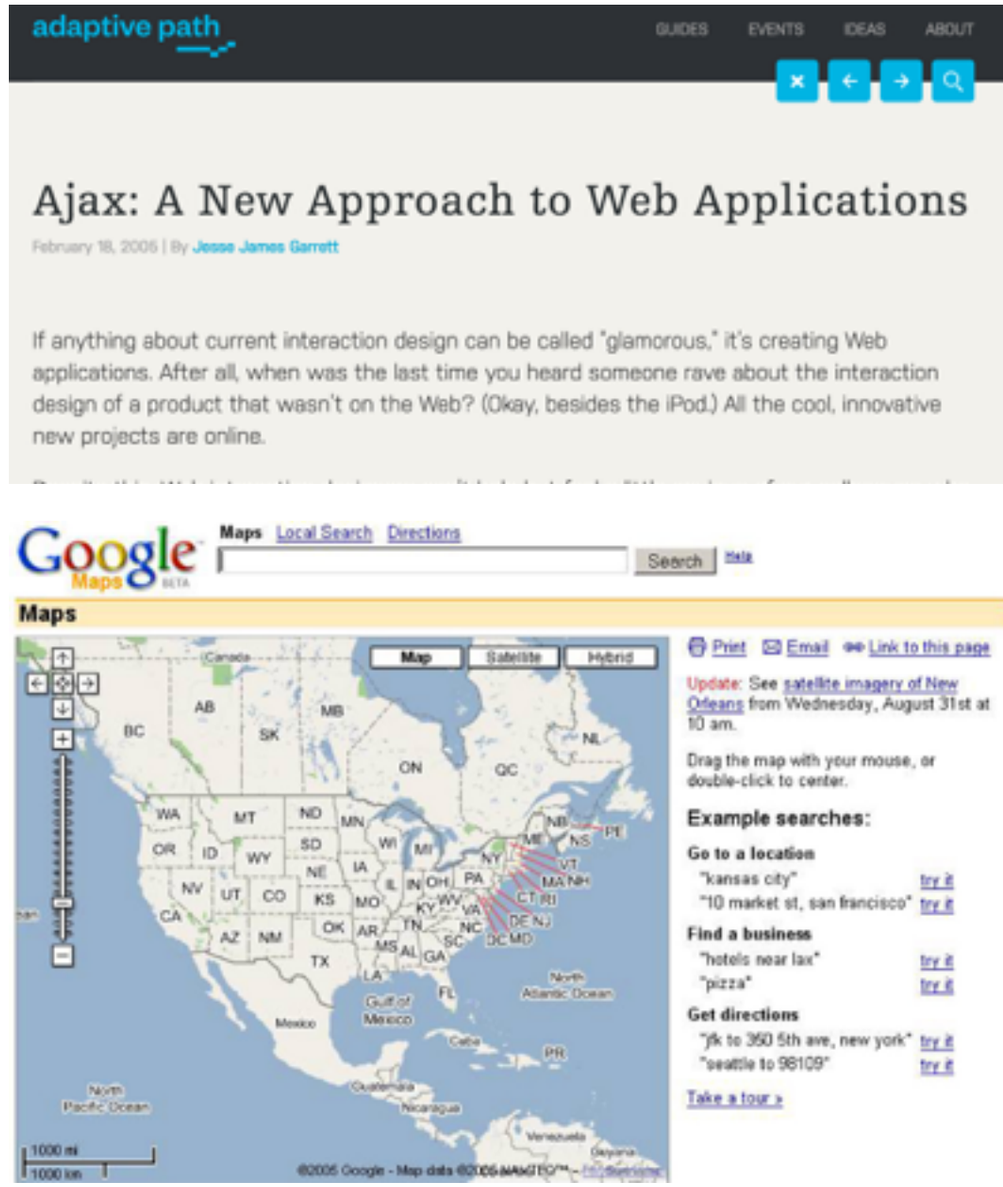
AJAX: Asynchronous JavaScript and XML

- Set of technologies to send and receive data from server asynchronously without interfering with behavior of page
  - HTML & CSS
  - DOM Manipulation
  - JSON or XML for data interchange
  - XMLHttpRequest for asynchronous communication
  - JavaScript
- Originally defined for XML. But representation independent, and now used mostly for JSON.



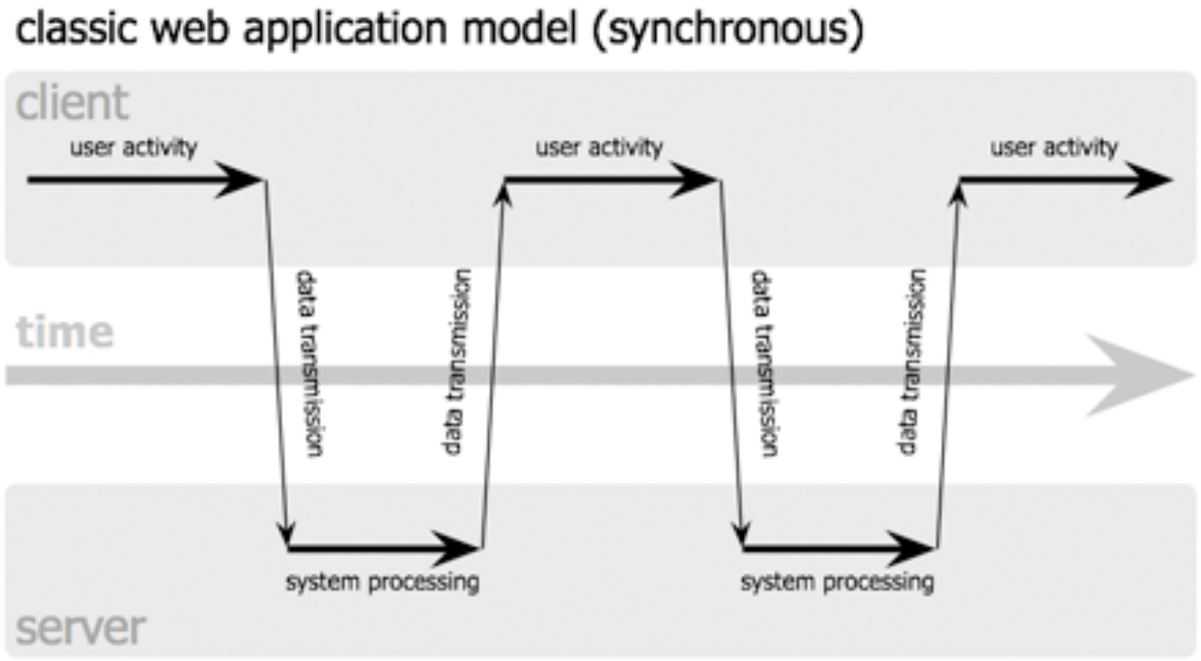
History

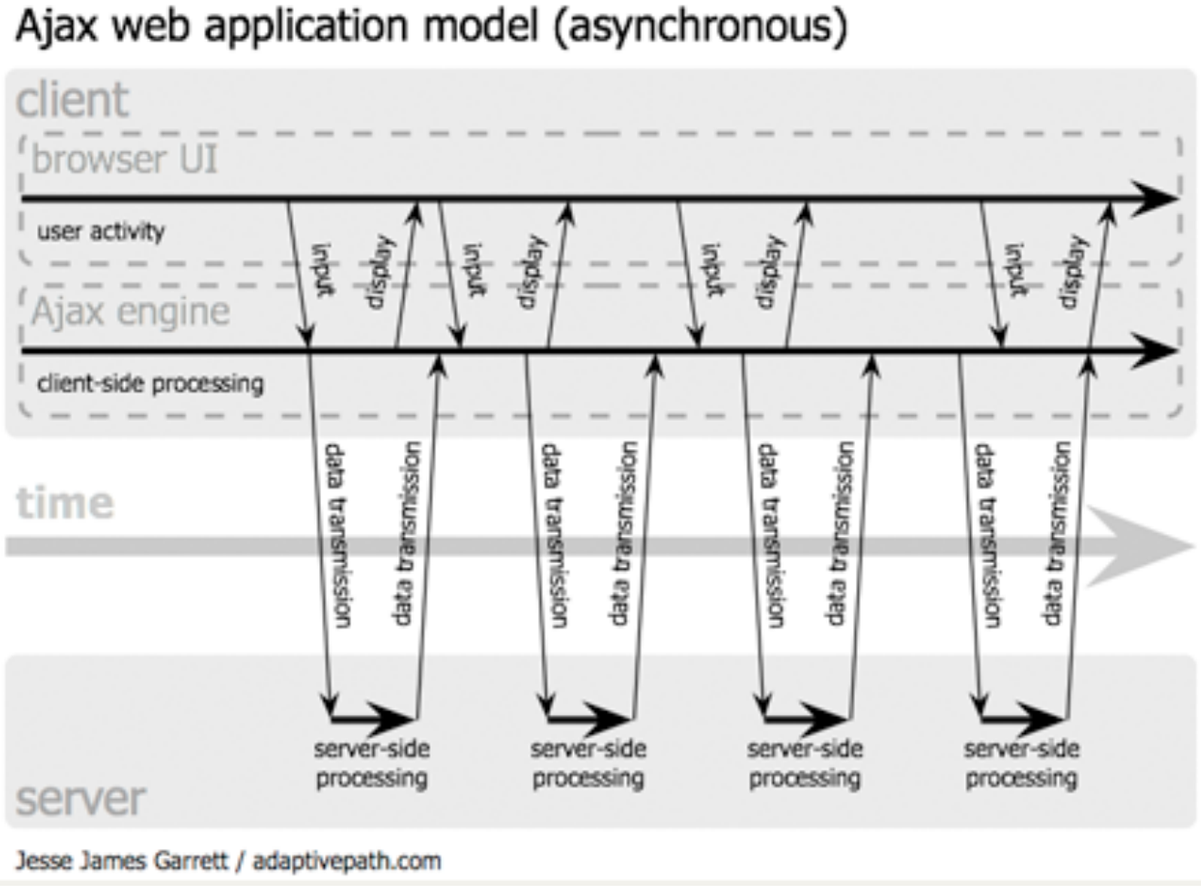
- 1998: Microsoft Outlook Web App implements first XMLHttp script
- 2004: Google releases Gmail with AJAX
- 2005: “AJAX: A New Approach to Web Applications” by Jesse James Garrett [1]
- 2005: Google Maps with AJAX
- 2006: W3C releases draft of XMLHttpRequest standard



[1] http://adaptivepath.org/ideas/ajax-new-approach-web-applications/

Synchronous vs. Asynchronous Requests





- Classic web apps require user to wait for response to server
- Asynchronous requests enable user to continue to interact with app

Example - Lazy Content Loading

- User changes visible viewport
  - JS code renders new area of map based on updated viewport
    - Check tile cache
      - If in cache, load tile from cache
      - If not in cache,
        - request tile from Google Maps Server

Lazy Content Loading

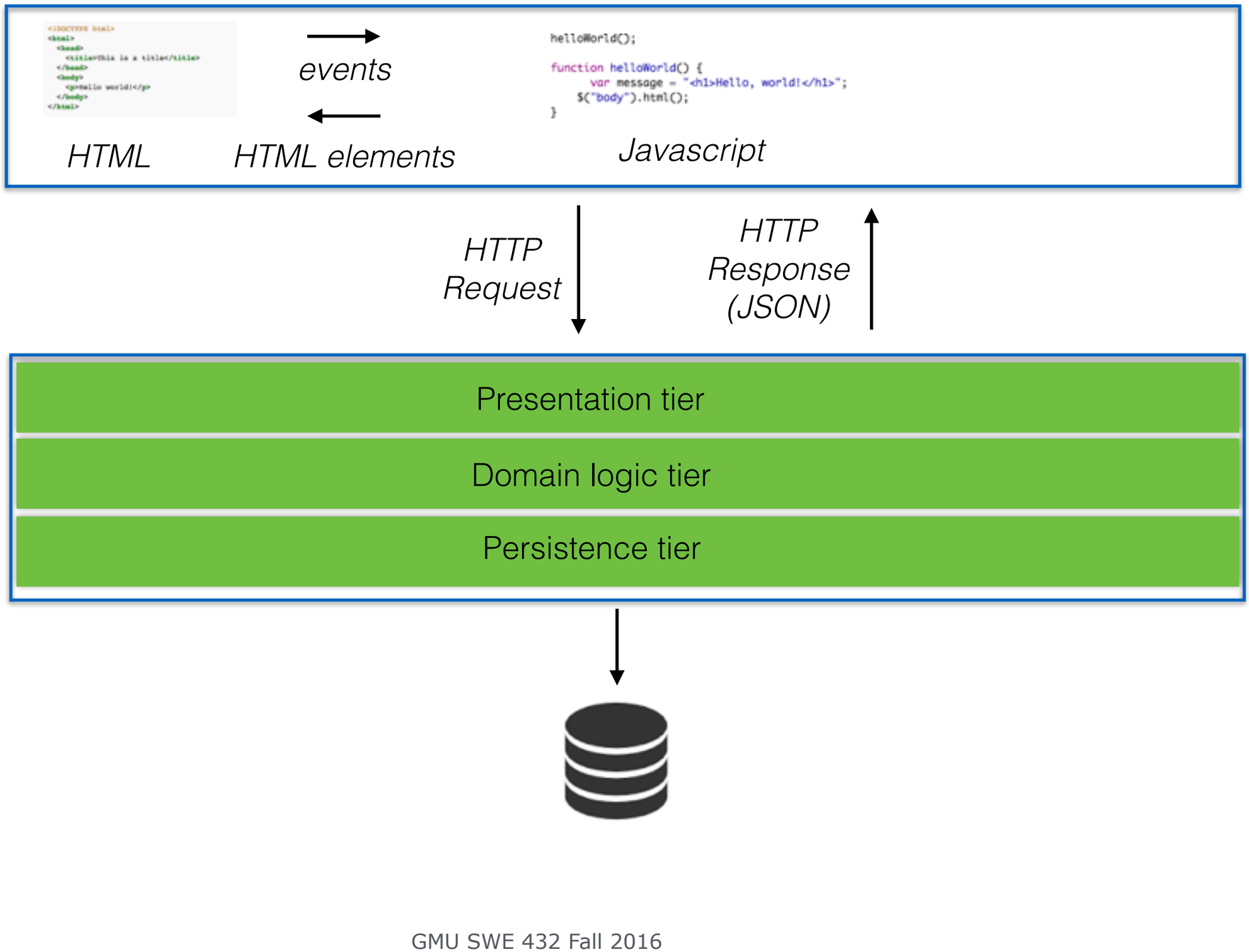
- Advantages:
  - Can have *vast* dataset that the user feels as if they are interacting with in real time
  - Only need to download content that user actually needs
  - Can (sometimes) do computation on client with really simple server that just fetches appropriate part of large data set

Some Uses for AJAX

- Lazily load content only when requested
  - e.g., FB newsfeed, Google Maps tile loading
- Load parts of web page from different hosts
  - e.g., advertisements, embedded Twitter widget, …
- Persist user data
  - In some cases, can do all computation client side
  - Enables building web app *without dedicated backend*
- Submit form data to server

Single Page Application Site

Browser



Web Server

Database

Single Page Application (SPA)

- Client-side logic sends messages to server, receives response
- Logic is associated with a single HTML pages, written in Javascript
- HTML elements dynamically added and removed through DOM manipulation

```
<b>Projects:</b>
<ol id="new-projects"></ol>

<script>
$( "#new-projects" ).load( "/resources/load.html #projects li" );
</script>

</body>
</html>
```

- Processing that does not require server may occur entirely client side, dramatically increasing responsiveness & reducing needed server resources
- Classic example: Gmail

Example: Weather

- Let's use a Web Service API to get the current weather.
- Will use the WeatherUnderground API.
  - https://www.wunderground.com/weather/api/d/docs?MR=1

Recall: HTTP

HTTP Request

```
HTTP GET http://api.wunderground.com/api/3bee87321900cf14/conditions/q/VA/Fairfax.json
```

HTTP Response

```
HTTP/1.1 200 OK
Server: Apache/2.2.15 (CentOS)
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true
X-CreationTime: 0.134
Last-Modified: Mon, 19 Sep 2016 17:37:52 GMT
Content-Type: application/json; charset=UTF-8
Expires: Mon, 19 Sep 2016 17:38:42 GMT
Cache-Control: max-age=0, no-cache
Pragma: no-cache
Date: Mon, 19 Sep 2016 17:38:42 GMT
Content-Length: 2589
Connection: keep-alive


{
  "response": {
  "version":"0.1",
  "termsofService":"http://www.wunderground.com/weather/api/d/terms.html",
  "features": {
  "conditions": 1
  }
   }
  ,   "current_observation": {
      "image": {
      "url":"http://icons.wxug.com/graphics/wu2/logo_130x80.png",
      "title":"Weather Underground",
```

Recall: HTTP

HTTP Request

```
HTTP GET http://api.wunderground.com/api/3bee87321900cf14/conditions/q/VA/Fairfax.json
```

HTTP Response

```
HTTP/1.1 200 OK
Server: Apache/2.2.15 (CentOS)
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true
X-CreationTime: 0.134
Last-Modified: Mon, 19 Sep 2016 17:37:52 GMT
Content-Type: application/json; charset=UTF-8
Expires: Mon, 19 Sep 2016 17:38:42 GMT
Cache-Control: max-age=0, no-cache
Pragma: no-cache
Date: Mon, 19 Sep 2016 17:38:42 GMT
Content-Length: 2589
Connection: keep-alive
```

JSON format response

JSON data

```
{
  "response": {
  "version":"0.1",
  "termsofService":"http://www.wunderground.com/weather/api/d/terms.html",
  "features": {
  "conditions": 1
  }
   }
  ,   "current_observation": {
      "image": {
      "url":"http://icons.wxug.com/graphics/wu2/logo_130x80.png",
      "title":"Weather Underground",
```

XMLHttpRequest

```
function reqListener () {
    console.log(JSON.parse(this.responseText));
}

var oReq = new XMLHttpRequest();
oReq.addEventListener("load", reqListener);
oReq.open("GET", "http://api.wunderground.com/api/
3bee87321900cf14/conditions/q/VA/Fairfax.json");
oReq.send();
```

"Parse into JSON"

"Listen for load

Event occurs when resou
finishes loading (i.e., when request completes).

"Execute"

This is a lot of typing…

- Offers standard API for making HTTP requests against servers.
- Used to be used for XML format data
  - But returns text which can be parsed into arbitrary format data

https://developer.mozilla.org/en-US/docs/Web/API/XMLHttpRequest/Using_XMLHttpRequest

jQuery AJAX

```
var jqxhr = $.ajax( “http://api.wunderground.com/api/
3bee87321900cf14/conditions/q/VA/Fairfax.json" )
.done(function() {
    console.log( jqxhr.responseJSON );  // JSON of response data
});
```

- Convenience wrapper for making HTTP requests using jQuery
- Defaults to GET method
  - Can specify post with type: “POST” or using $.post(…)
- Looks at content-type response header to determine parser
  - Can override with data-type (e.g., data-type: “JSON”)

http://api.jquery.com/jquery.ajax/

AJAX w/ jQuery

- Can use AJAX to load or send resources of any type
  - HTML, CSS, JSON, text, JS, XML, images, …
  - Content-Type HTTP header describes format
- Load JS file and run it
  - $.load(…)
- Combine DOM manipulation w/ HTTP request
  - $(“#result”).load(“ajax/test.html”);
  - Requests data from server, updates selected elements with returned HTML

Demo: Sentiment Analysis Web Service

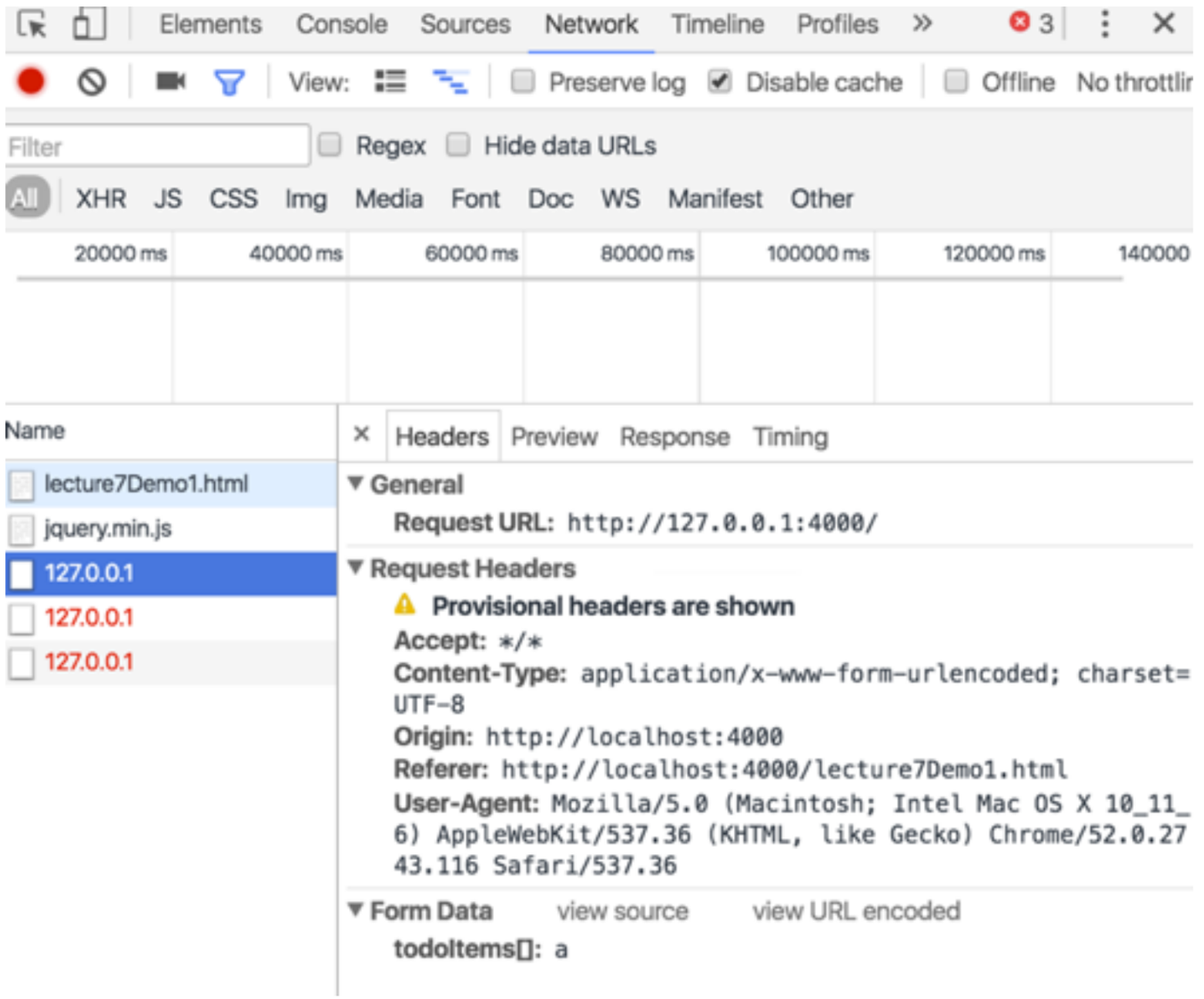
Very similar to the news demo I posted online

But instead we use POST + AJAX

Tricks: Host static files using express

Troubleshooting AJAX

- Make sure that the data sent to server is a JSON ***object***
  - Not an array, String, primitive, etc.
- Check for errors (will look at this next time)
- Inspect HTTP requests through the Network tab on the Developer tools



API keys

- Problem: limiting request to a web service
  - Handling requests costs time and money
  - But still want to let developers play with service for free
  - And want to bill heavy users based on usage
- Solution: API key
  - e.g., AIzaSyDPyU6iHOovjYYONyFxixI9NRYQKIxfR0A
  - Generate a unique key for each user
  - Require all calls to API to provide key
  - Monitor use & bill based on key provided
  - DO NOT want to let these API keys be released publicly!

Packaging web services

- Web services are sometimes packaged as library.
  - Include an external library through a <script> include
  - Library itself makes AJAX calls to remote host.

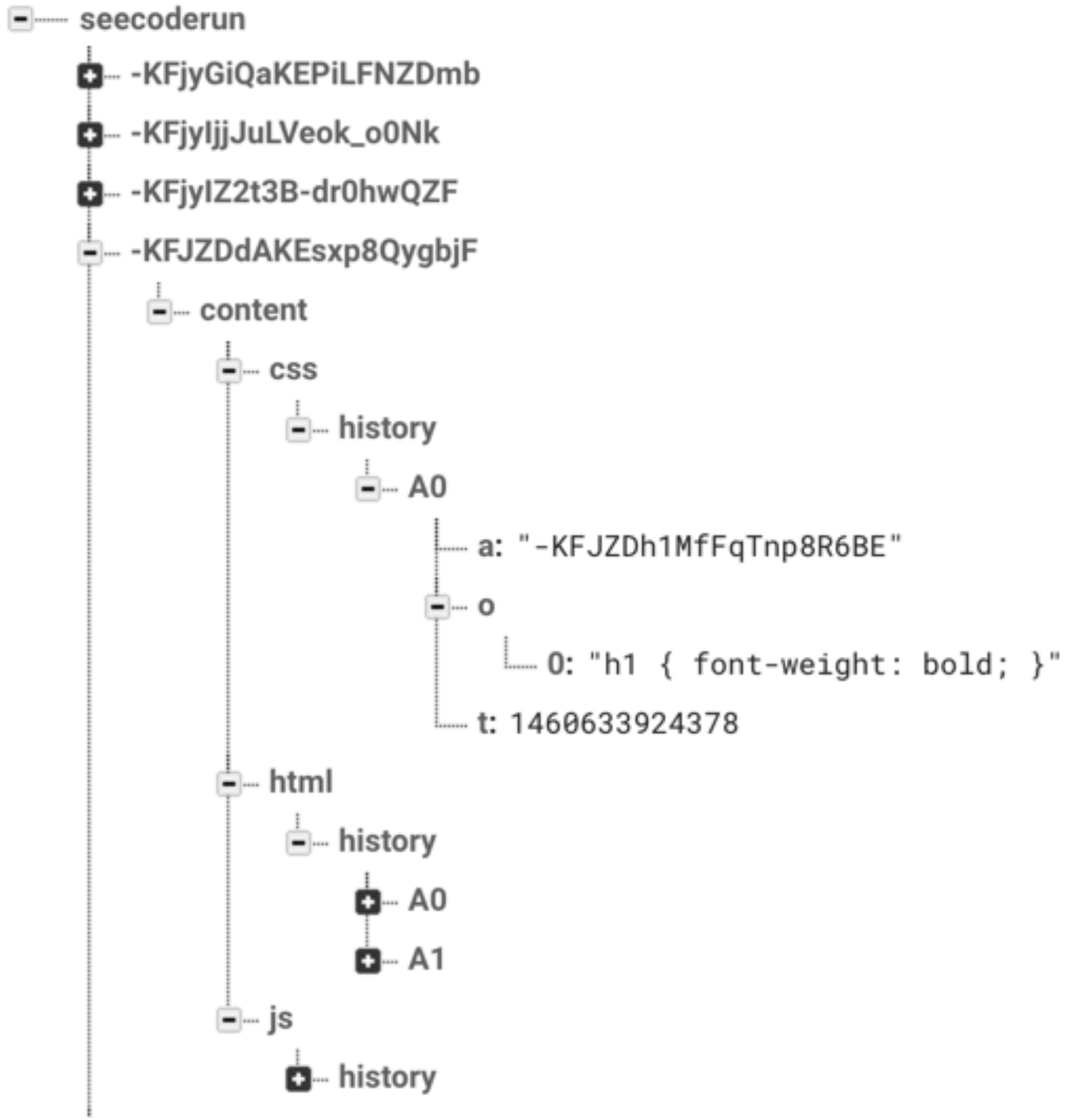
- Advantages
  - Makes possible higher level abstractions for interacting with web service
    - Don’t have to worry about individual HTTP requests
  - Can implement caching of data received from server
  - Can maintain local state of data when server may not be available

Example: Firebase Realtime Database

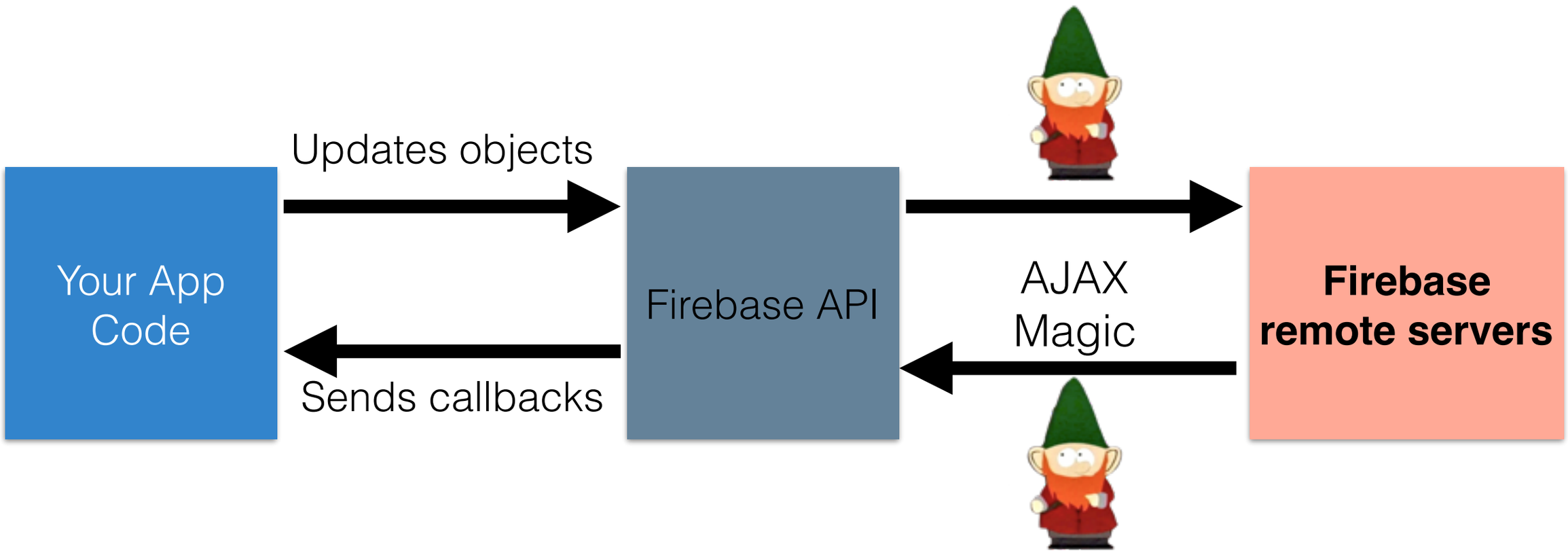
- Google web service
  - https://firebase.google.com/docs/database/
- Realtime database
  - Data stored to remote web service
  - Data synchronized to clients in real time
  - Simple API
    - Offers library wrapping AJAX calls
    - Handles synchronization of data
- Can build web apps with persistence without backend
- Magically makes it look like all data is local

Firebase data model: JSON

- JSON format data
  - Hierarchic tree of key/value pairs
- Can access arbitrary node in tree
  - Just like JSON object…
- Offers realtime console
  - Shows data values in realtime
  - Edit data values



Firebase data model: JSON



Storing Data: Set

```
function writeUserData(userId, name, email, imageUrl) {
    firebase.database().ref('users/' + userId).set({
    username: name,
    email: email,
        profile_picture : imageUrl
    });
}
```

"On the active firebase database"

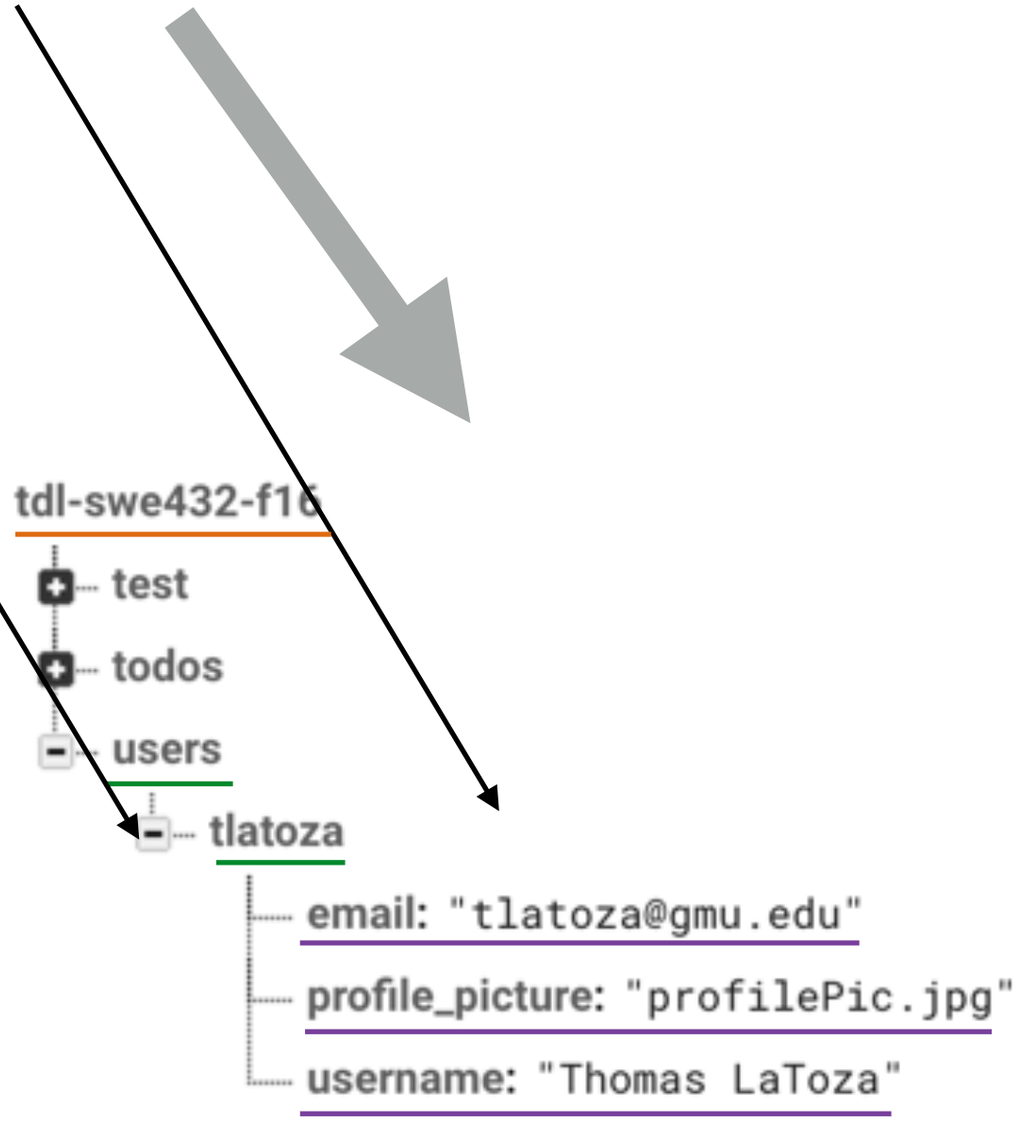
Must be initialized first (coming soon….).

"Get the users/[userID] node"

Arbitrary nodes in the tree can be addressed by their path.

"Set value"

Sets the value to specified JSON.



Storing Data: Push

```
var key = firebase.database().ref().child('posts').push(
    { author: username, uid: uid, body: body, title: title });
```

- What about storing collections?
  - Use push to create key automatically
    - All data MUST have a key so it can be uniquely referenced
      - Arrays given index keys
    - You really should not ever make your own keys
    - Should never have multiple clients synchronizing an array
      - Local indexes could get of sync with remote keys
      - Instead, use JSON object with number as key

Storing Data: Delete

```
firebase.database().ref().child('posts').remove();
```

Removes the 'posts' subtree.

- Can delete a subtree by setting value to null or by calling remove on ref

Listening to data changes

```
var starCountRef = firebase.database().ref('posts/' + postId + '/starCount');
starCountRef.on('value', function(snapshot) {
    updateStarCount(postElement, snapshot.val());
});
```

"When values changes, invoke function"

Specify a subtree by creating a reference to a path. Listen to one or more events by using on(eventName, eventHandlerFunction(snapshot))

- Read data by *listening* to changes to specific subtrees
- Events will be generated for initial values and then for each subsequent update

Data Update Events

- Types of events
  - value: entire contents of a path
  - child_added
  - child_changed
  - child_removed
- Can listen to events on any part of subtree
  - Could have subtrees that correspond to different collections of data
  - Should always listen to *lowest* subtree of interest to minimize extraneous communication
- Can read data exactly one time (and not get updates) using once

Ordering data

- Data is by, default, ordered by key in ascending order
  - e.g., numeric index keys are ordered from 0…n
  - e.g., alphanumeric keys are ordered in alphanumeric order
- Can get only first (or last) n elements
  - e.g., get n most recent news items

```
var recentPostsRef = firebase.database().ref('posts').limitToLast(100);
recentPostsRef.once('value', function(snapshot) {
    displayPost(snapshot.val());
});
```

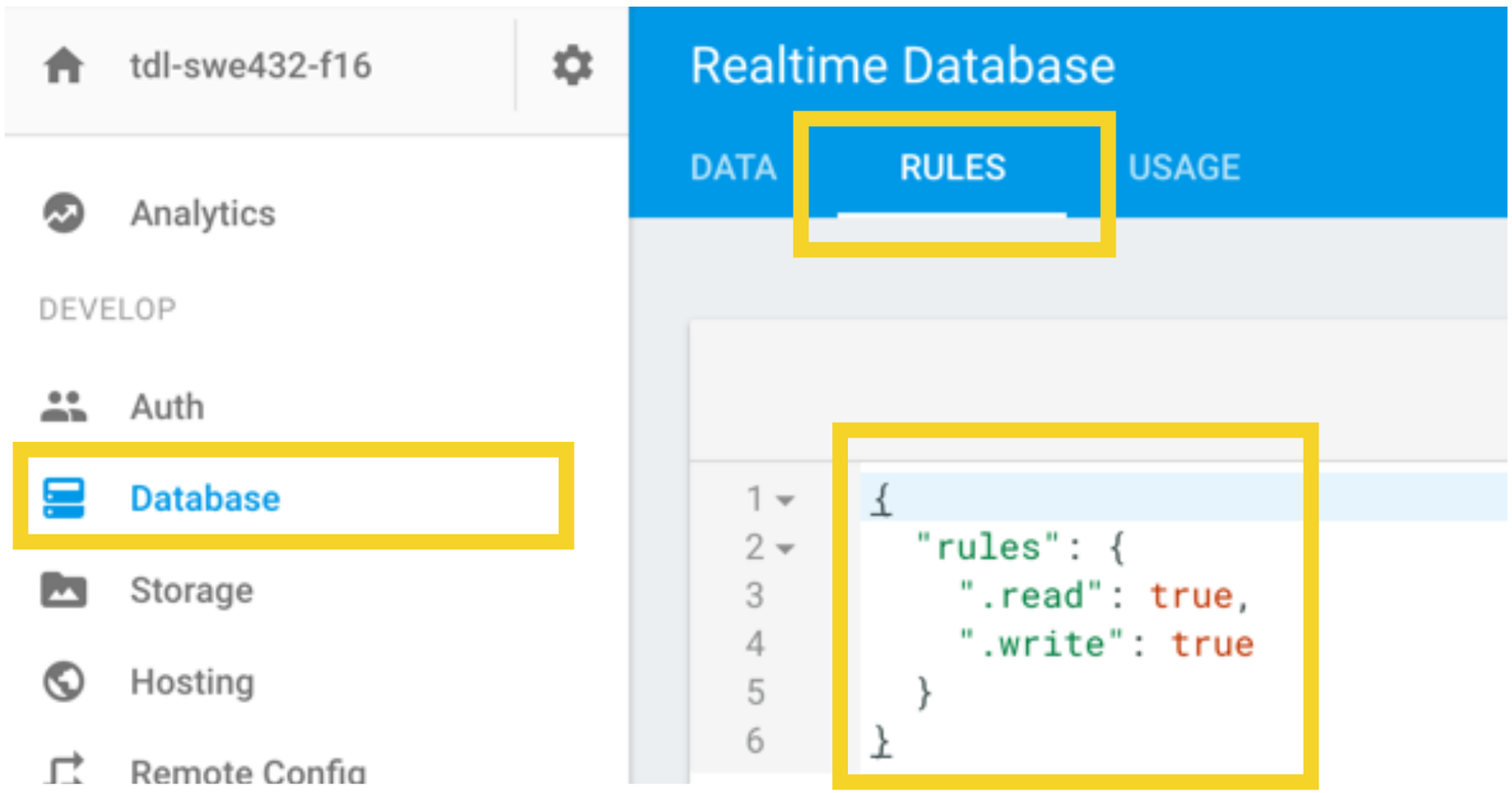
Setting up Firebase

- Detailed instructions to create project, get API key
  - https://firebase.google.com/docs/web/setup
  - You should run through web server, not localhost

```
<script src="https://www.gstatic.com/firebasejs/3.4.0/firebase.js"></script>
<script>
// Initialize Firebase
// TODO: Replace with your project's customized code snippet
var config = {
    apiKey: "<API_KEY>",
    authDomain: "<PROJECT_ID>.firebaseapp.com",
    databaseURL: "https://<DATABASE_NAME>.firebaseio.com",
    storageBucket: "<BUCKET>.appspot.com",
};
firebase.initializeApp(config);
</script>
```

Permissions

- By default, Firebase *requires* authentication
  - All unauthenticated requests will be refused
  - Do not want anyone with your URL to steal, destroy your production data
  - Will look at authentication in later lecture
  - For development, ok to allow anonymous access



Firebase Demo