

Mobile Computing

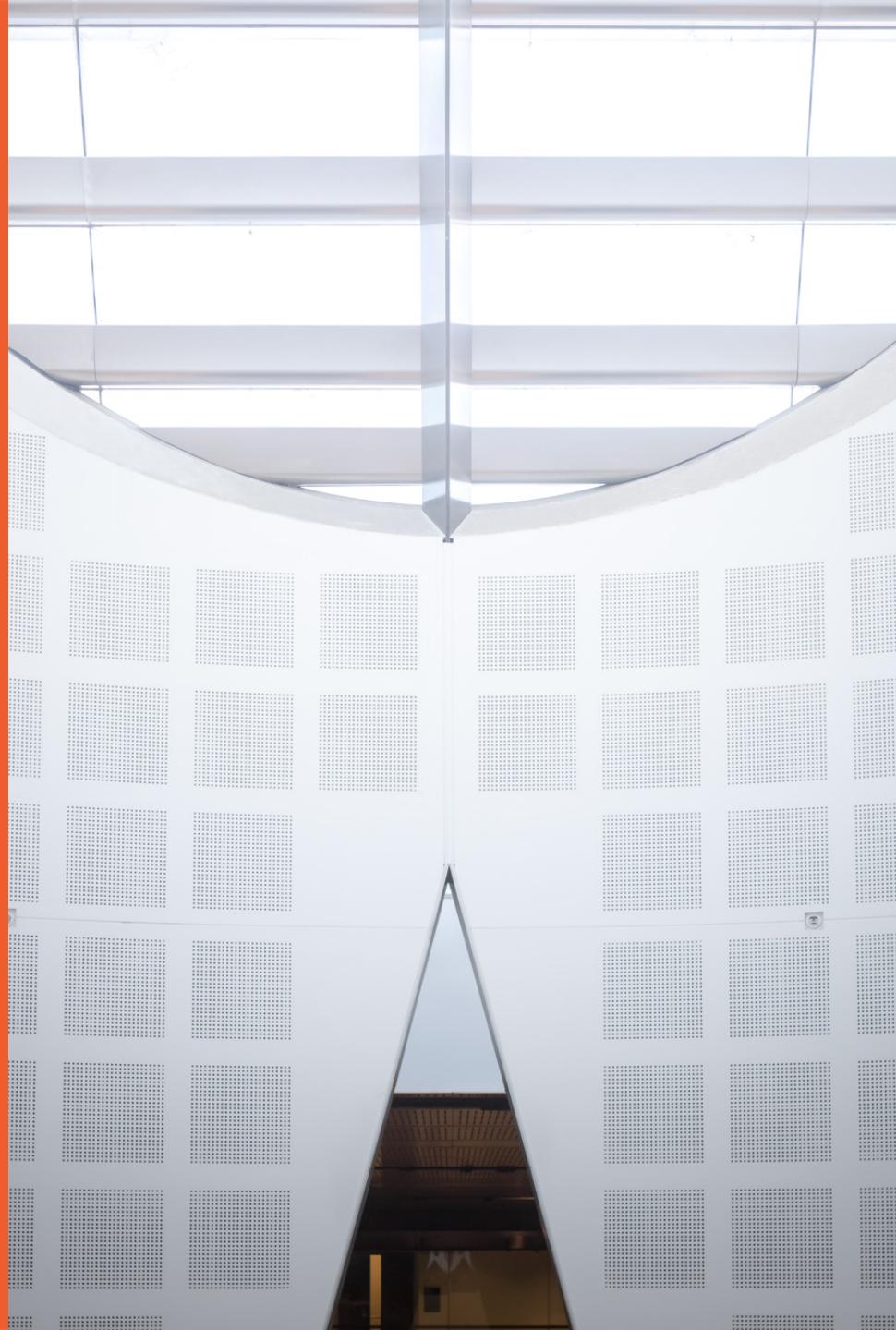
COMP5216

Week 04
Semester 2, 2020

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School of Computer Science



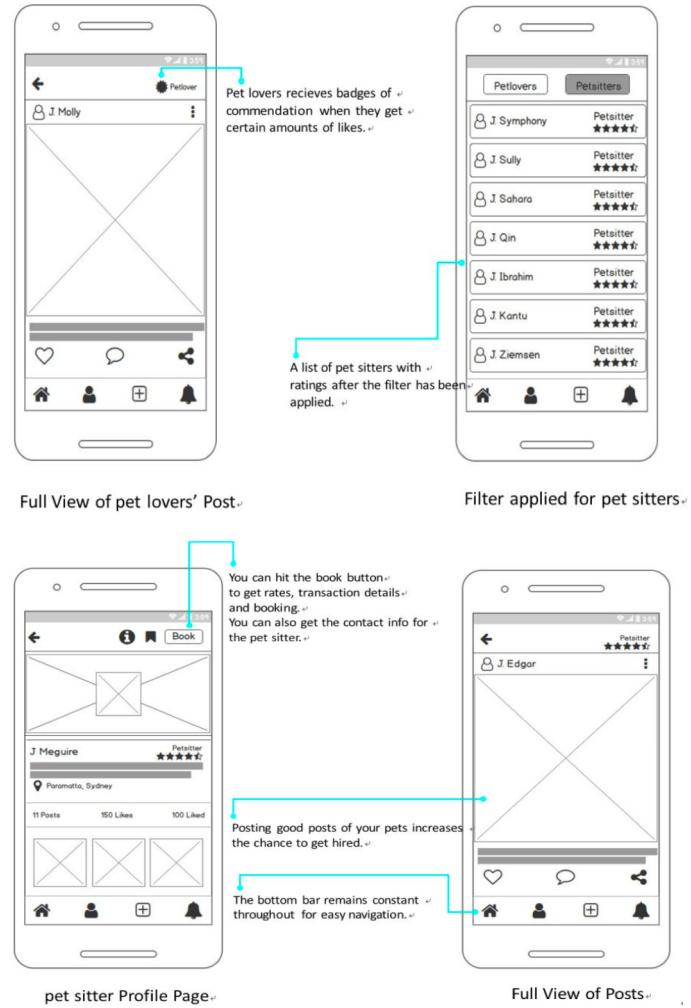
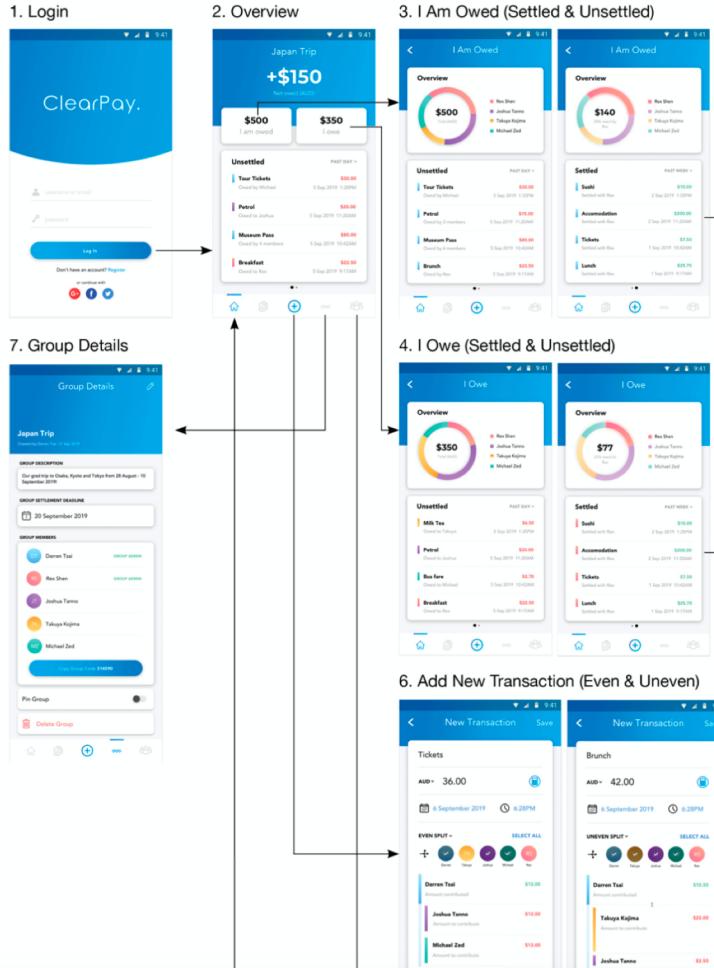
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Announcements

- It's great that you are talking...!
- What should be in the proposal?
 - **App:** background, related work, significance, requirements, and etc;
 - **Solution:** explain how you are going to implement your solution describing the proposed workflow of the app and technical approaches that are required to implement the solution.
 - **Plan:** the implementation schedule, workload distribution among the group, how to develop collaboratively; and
 - **Potential setbacks:** identified risks, threats and proposed solutions;
 - References

E.g. Workflow of the app



E.g. Technical approach

System Architecture/Technical Approaches

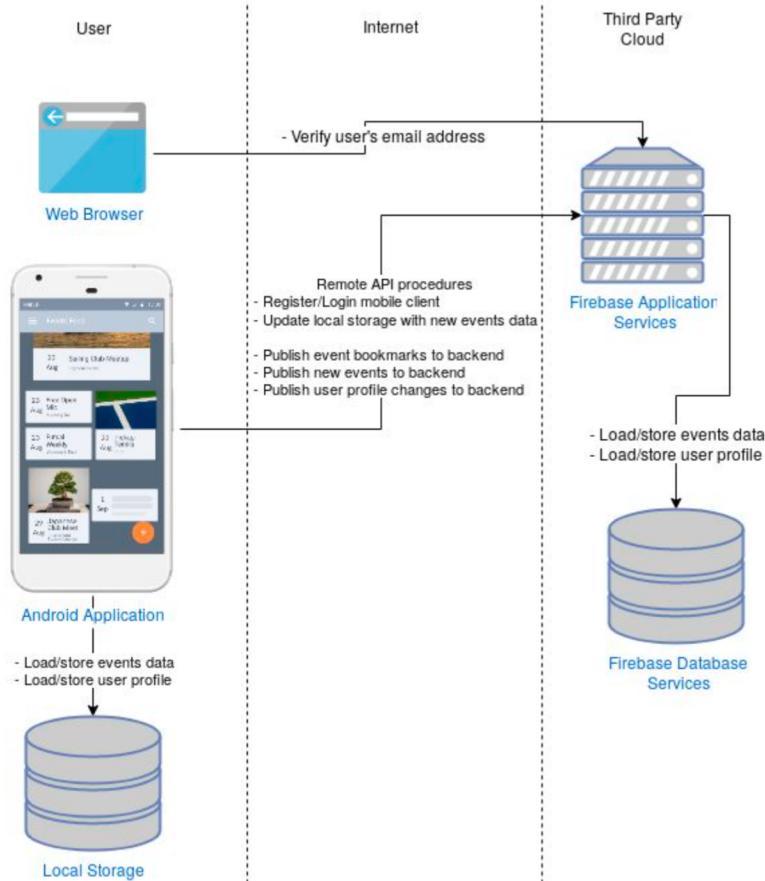


Image: What's On system architecture diagram.

- How you going to technically realize your app?
 - Do you need server support?
 - Are you going to rely on external libraries?
 - What are the API that you going to use?
 - Any specific ML models?
 - Etc...

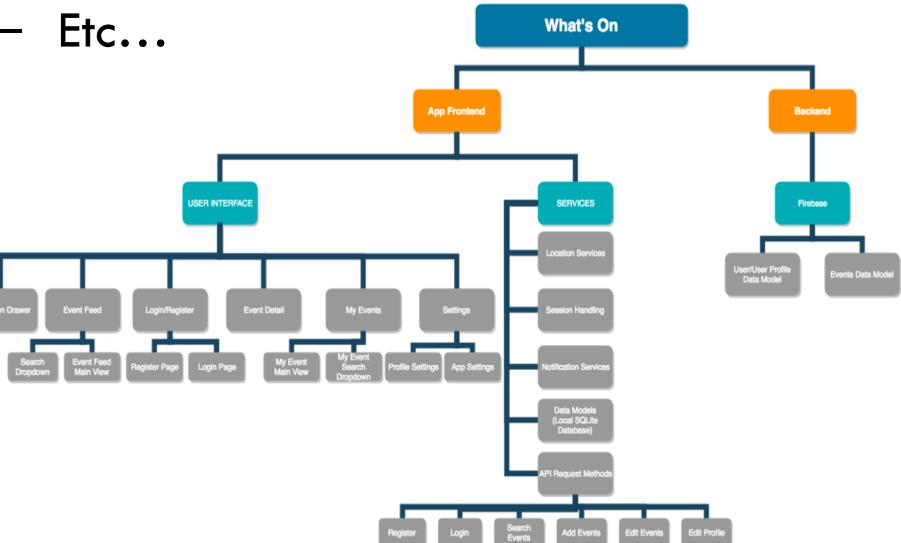


Image: Work breakdown structure for the What's On application and backend services.

Outline

- User Quality of Experience
 - What to avoid ?
- Challenges in Mobile computing
 - Structure of the course
- E.g. Challenges in determining user location
 - Option 1
 - Option 2
- Google Play Services
- Internet Protocol Basics

User Quality of Experience (QoE)

- The main challenge
- Extremely difficult to measure – why ?
 - It is highly personal

- Perception
- Culture
- Age
- Mood
- Gender
- Profession



User Quality of Experience (QoE)

- How users react to apps also depends on...
 - Time of the day
 - Check weather in the morning vs checking whether at night
 - Season
 - Rainy vs Summer
 - Current activity
 - Sitting in a couch vs standing on board crowded train

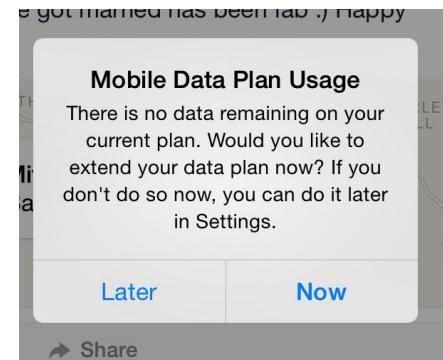
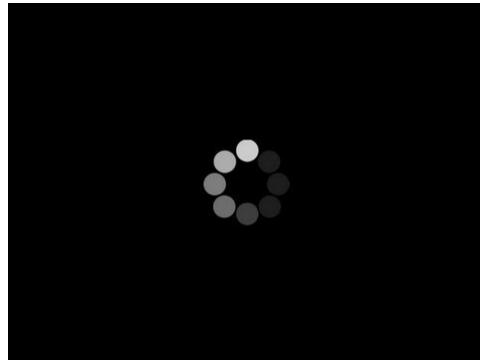


Understand your customer

- Target a specific customer segment at the beginning
 - Snapchat → Teenagers
- What are the common things that annoy us ?



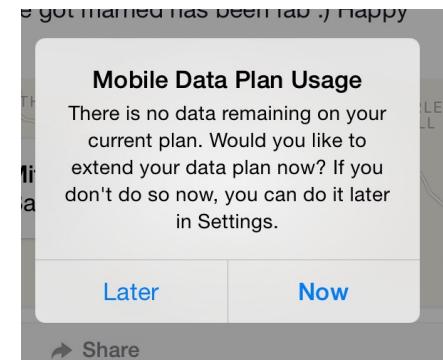
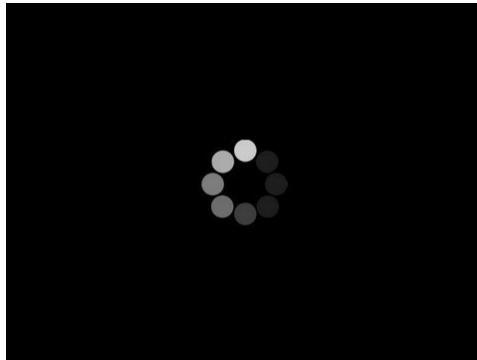
What to avoid ?



User perception threshold – 50-100ms

Trewin, S., Swart, C., Koved, L., Martino, J., Singh, K., & Ben-David, S. (2012, December). Biometric authentication on a mobile device: a study of user effort, error and task disruption. In *Proceedings of the 28th Annual Computer Security Applications Conference* (pp. 159-168). ACM.

What to avoid ?



- Potential causes
 - Faulty battery or device
 - Network issues
 - High speed mobility
 - Trying to download too much data
 - Not the right data flow
 - Too complex data processing
 - Not the right network for communication
 - Too frequent communication
- 
 - **Network**
 - **Computing**
 - **Energy**

What to avoid ?

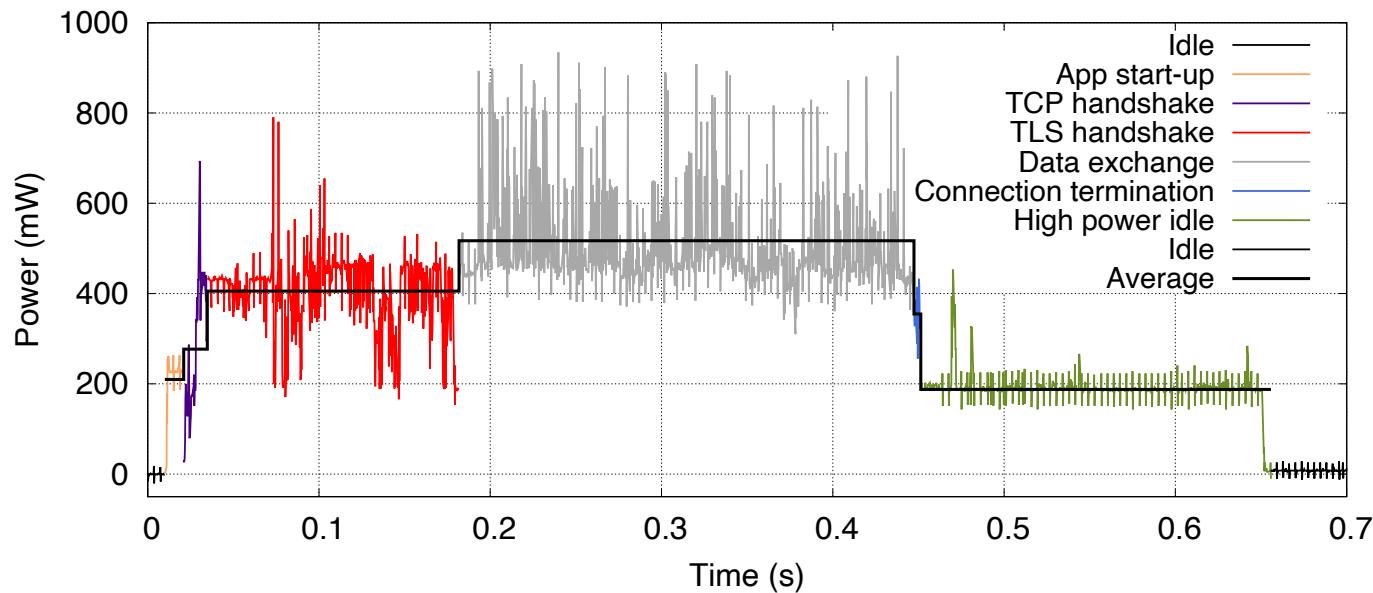


- **STRIDE threat list**
 - Spoofing, Tampering, Repudiation, Information Disclosure, Denial of Service , Elevation of Privileges
- Potential causes
 - User mistakes
 - Unsecure communication
 - Unsecure storage of user data
 - Malicious ad library

} – **Security**
– **Privacy**

E.g. Power vs Communication

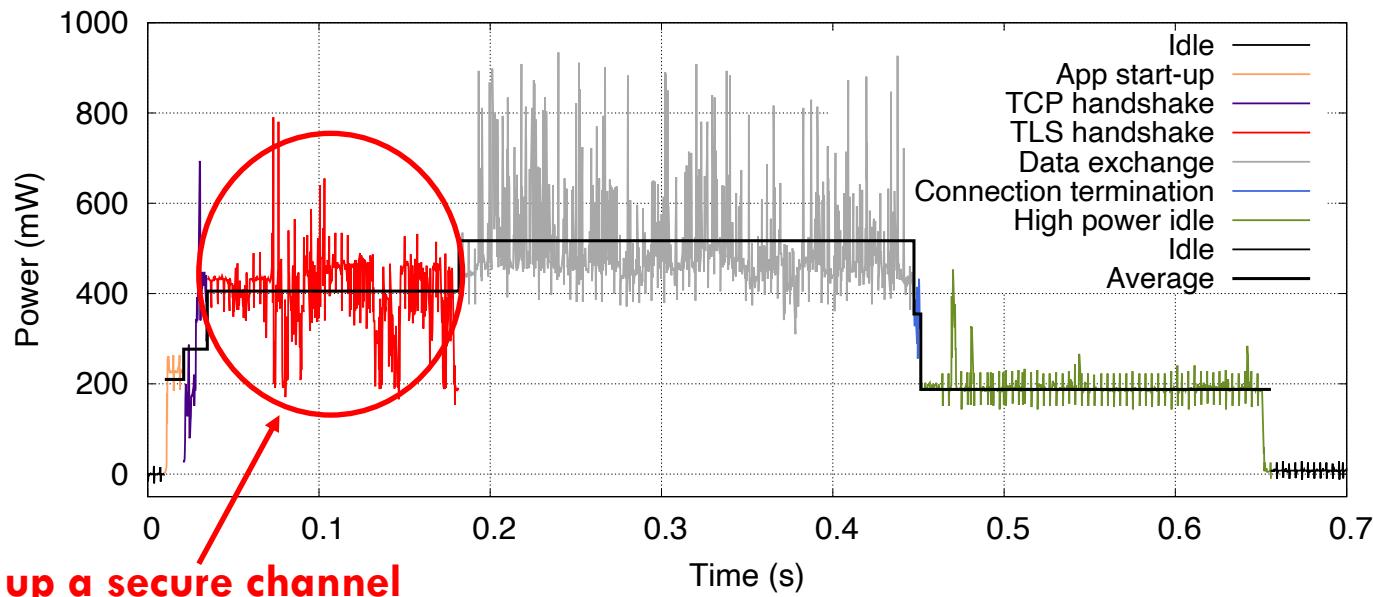
- Power consumption for HTTPS data transfer



- You design your app to transfer 1KB of data to your app server at every one 10 seconds.
 - What are the consequences ?

E.g. Power vs Security

- Power consumption for HTTPS data transfer



- Every action has consequences

Course Schedule

- We are going to have one lecture for each challenge

Week	Lectures	Labs/Tutorials
5	Mobile Networking	Media access
6	Mobile Security & Privacy	AR/VR
7	Mobile Cloud & Energy	User management

- There are other challenges:
 - User Interaction (did talk about them a bit on Week 2)
 - Policies and regulations
 - Advertising
 - App analytics
 - Monetization

Challenges in determining device location

Week 4, COMP5216



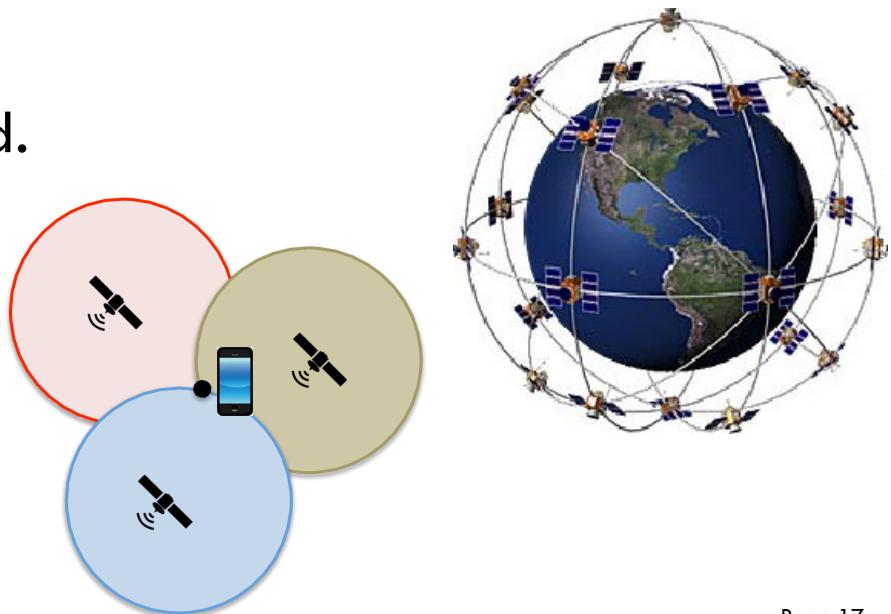
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Challenges in determining device location

- Location adds “**Context**” to every action.
- The biggest challenge - User is moving.
- Various sources to determine the location.
 - GPS
 - Assisted-GPS
 - Cell towers
 - ...
 - ...
- **Each source comes with different accuracy, availability, resource requirement and efficiency**
- Dependent on the environmental factors.

The Global Positioning System (GPS) Location

- Provided by the United States government
<https://www.gps.gov>
- **Use the signals received from satellites for localisation.**
- Each location in the world is covered by at least four satellites.
- User device receives the signal and measure the time lag to estimate the distance to each satellite.
- No data connection is required.
- Longer time-to-fix.
 - Identifying the satellites
 - Synchronising the clocks.

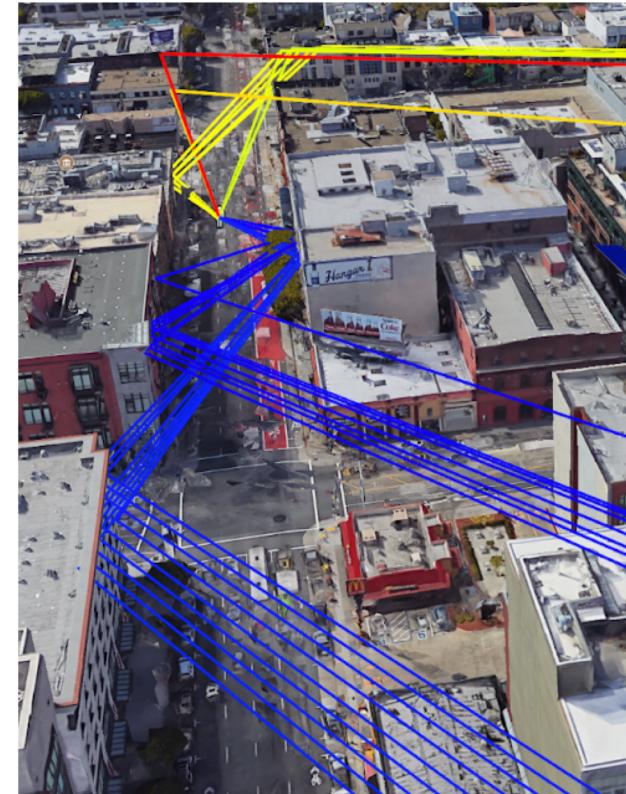


GPS Accuracy

- Standard Positioning Service (SPS)
 - Available to all users
 - No restrictions or direct charge
 - high-quality receivers have accuracies of 3m and better horizontally
 - **In the level of 5-10m in worst case.**
- Precise Positioning Service (PPS)
 - Used by US and Allied military users
 - Use more satellites than public service
- US Government can selectively deny access
 - GLONASS (Russian), BeiDuo (China), Galileo (EU), NAVIC (India)

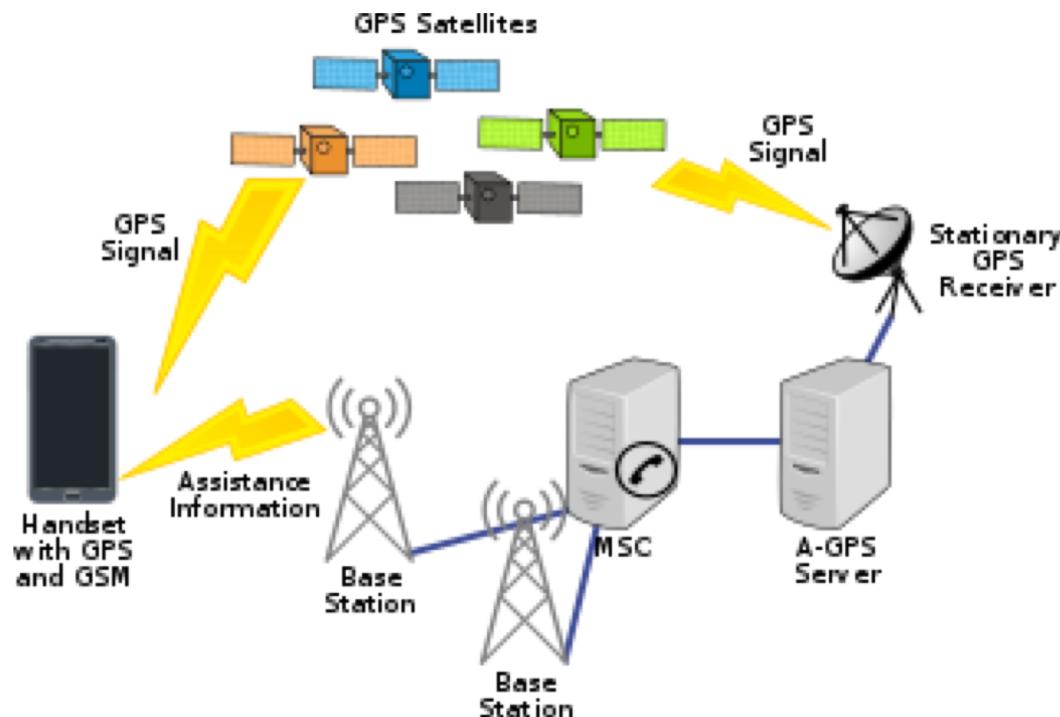
GPS Location

- Smartphones can connect to multiple constellations to improve the accuracy: GPS or GLONASS & use the combined result.
 - Many apps in Google Play Store to check the status of GPS signals
- However, GPS is not available everywhere, especially indoors.



Assisted GPS

- Tries to address some of the problems in GPS.
- Faster set-up time by getting satellite information through data connection.
- Lower energy consumption

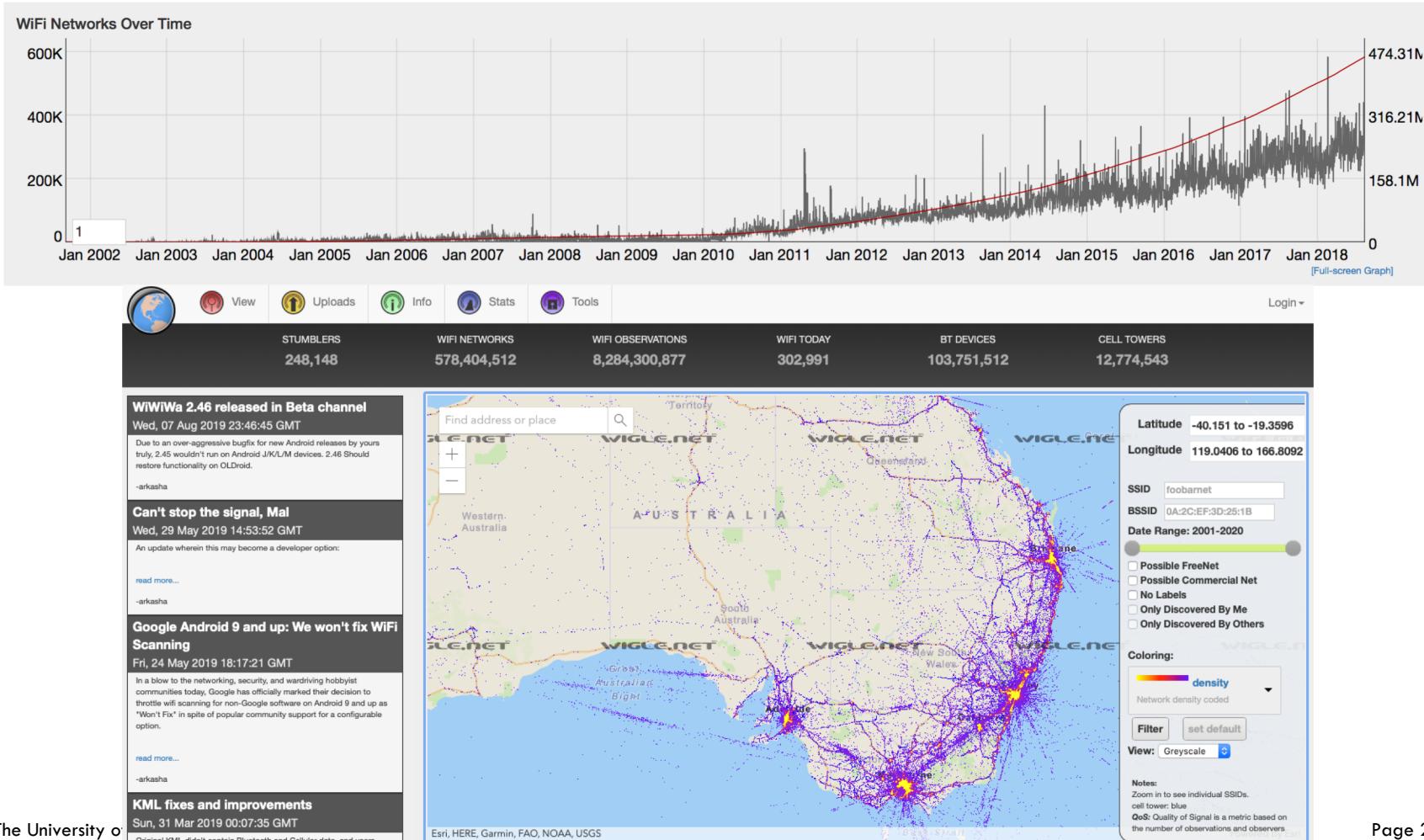


Network Location

- Use near by cell tower & WiFi access point information to query a geo tagged database.
- Energy Efficient.
- Needs a user data connection.
- Who provide data to the geo DBs? – Everyone
 - It has been happening for sometime now
<https://www.zdnet.com/article/how-google-and-everyone-else-gets-wi-fi-location-data/>

Network Location

- WIGLE public database
 - www.wigle.net



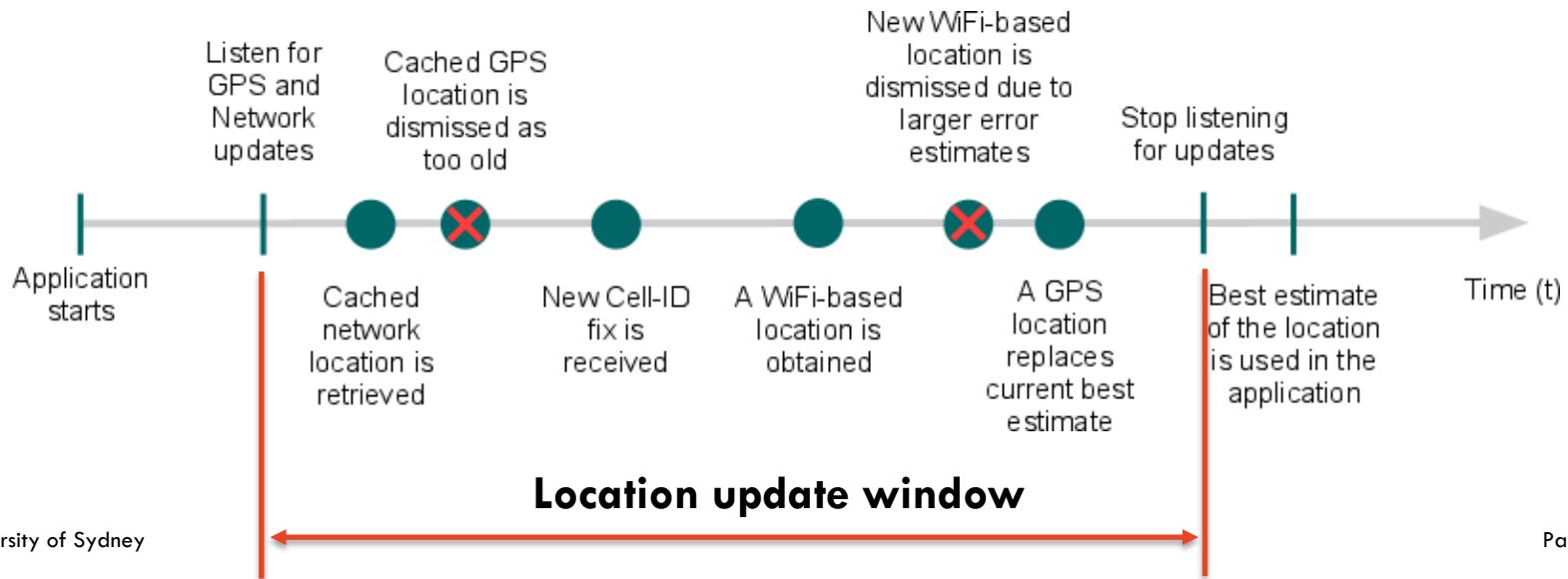
How to get location in Android – Option 1

- **Location API** in `android.location` [1]
 - There are two main location providers:
 - `GPS_PROVIDER`
 - `NETWORK_PROVIDER`
 - `PASSIVE_PROVIDER`
- Ask for the necessary permissions for the location providers.
 - `GPS_PROVIDER`:
`<uses-permission android:name= "android.permission.ACCESS_FINE_LOCATION" />`
 - `NETWORK_PROVIDER`:
`<uses-permission android:name= "android.permission.ACCESS_COARSE_LOCATION" />`

[1] <https://developer.android.com/reference/android/location/LocationManager>

How to get location in Android – Option 1

- Flow for obtaining user location
 - Start application
 - Start listening to location
 - Get the cached location
 - **Maintain “best-estimate” filtering out less accurate updates**
 - Stop listing to location
 - Use last “best-estimate”



How to get location in Android – Option 1

- Start of the window
 - As soon as app starts or after a certain user action
- Period of the window
 - Long – More battery
 - Short – Less accurate
- Maintain the “best-estimate”
 - Most recent fix is not always the best
- PASSIVE_PROVIDER
 - Getting the location fix often takes too long
 - Provides locations without actually initiating a location fix.
 - Only returns locations generated by other providers

Android – Option 1: Best practices

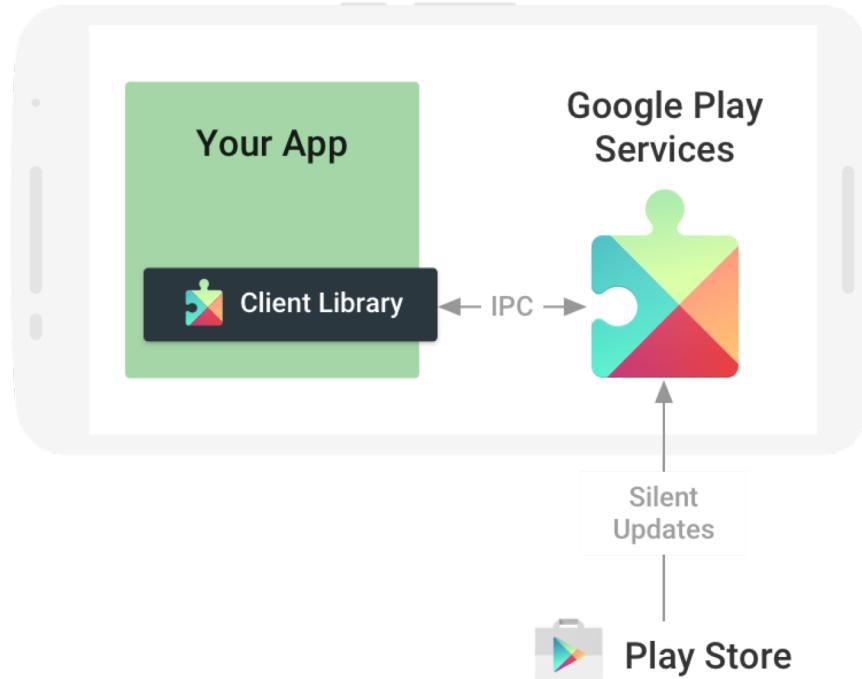
- Reduce the size of the window
 - As soon as you receive the information you need, stop listening to location
- Reduce the frequency of Location Provider access
- Restrict a set of providers
 - More provider – More battery
- App developers must not be troubled with all of these problems !!

How to get location in Android – Option 2

– Fused Location Provider API

- Current method [**Recommended by Google**].
- Google Play Services
- <https://developers.google.com/location-context/fused-location-provider>
- <http://developer.android.com/training/location/index.html>
- Provides a much higher level view for the developer.
- Automatically changing the appropriate Location Provider, e.g. GPS or WiFi
- Your app must do is specify the desired level of service.
- Better accuracy and power management.

Google Play Services



- Google Play services is installed as a separate application
- Run as a background Service
- <https://developers.google.com/android/guides/setup>

Advantages of Google Play Services

- According to Google:
 1. Google Play services provide a **simple interface** and a cleaner API surface.
 2. You specify a desired quality of service and the APIs **manage the underlying technologies** for you.
 3. The Google Play services APIs are **optimized for performance** and battery usage.
 4. The Google Play services APIs are **actively maintained**. Google is constantly improving the algorithms and adding more features.

Back to - How to get location in Android – Option 2

- How ? → Tutorial – Week 10

Optimize location for battery & efficiency

Recall:

- **Accuracy:** higher the accuracy, the higher the battery drain.
- **Frequency:** More frequent location is computed, the more battery is used.
- **Latency:** Less latency usually requires more battery.
- **Step 1:**
 - Utilize cached location via `getLastKnownLocation(String)`:
 - Getting the location fix often takes too long and more resources

Accuracy – Google Play Services Location

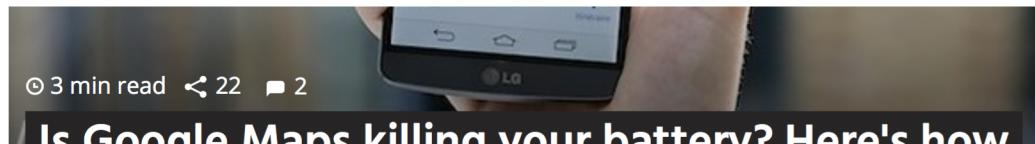
- Specify location accuracy using the `setPriority()` method
- **PRIORITY_HIGH_ACCURACY**
 - Most accurate
 - Use as many providers as necessary (GPS, WiFi, Cell-towers, etc.)
- **PRIORITY_BALANCED_POWER_ACCURACY**
 - Accurate location
 - Rarely uses GPS.
- **PRIORITY_LOW_POWER**
 - Coarse (city-level) accuracy
 - Mostly using on cell towers
- **PRIORITY_NO_POWER**
 - Passive location
 - Rely on location computed by other apps

Frequency & Latency – Google Play Services Location

- **setinterval()** method
 - The interval at which *location is computed for your app.*
 - Larger the better for battery
- **setMaxWaitTime()** method
 - Larger the better for battery
 - Delays the delivery of location
- Combination of the two methods can be used to batch requests
 - Set **setMaxWaitTime()** several times larger than **setinterval()**
- Set timeout to avoid keep trying
 - **setExpirationDuration()**

Google Play Services Location APIs

- Seems a lot easier than Location APIs
- Why is it necessary to learn all location access methods ?
- **Low flexibility**
 - E.g. Can not restrict your app to receive only WiFi location.
- Not so easy after all...



Kris Carlson
Aug 28, 2014

Google Maps battery draining issue: Here is how you can fix it

Wondering how to fix Google Maps battery draining issue? battery caused by Google Maps background processes

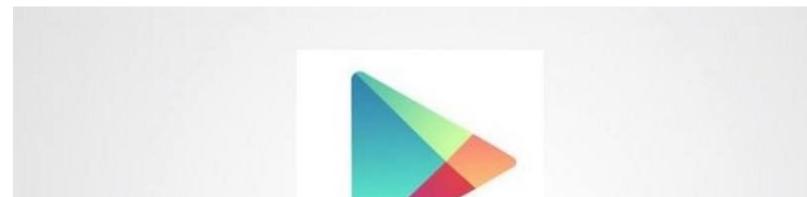
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SHARES



Written by [Meghna Dutta](#) | New Delhi | Updated: August 3, 2018 1:30:34 pm

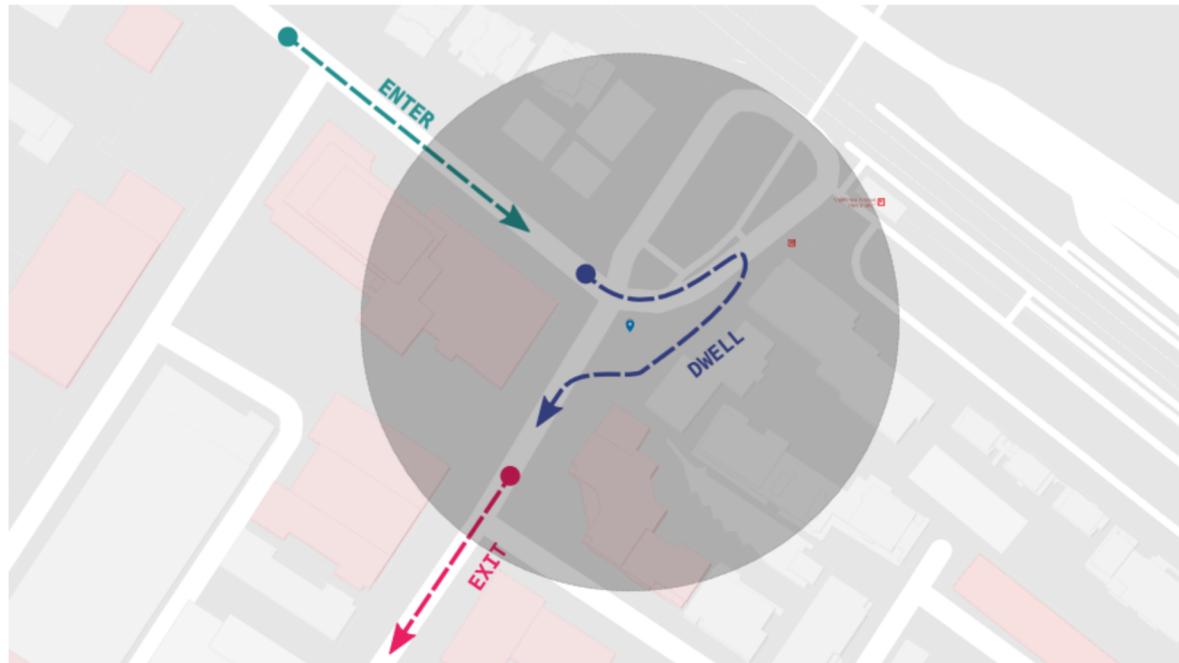
How to Fix Google Play Services Battery Drain on Android

By [Robert Zak](#) / Mar 15, 2020 / [Android](#)



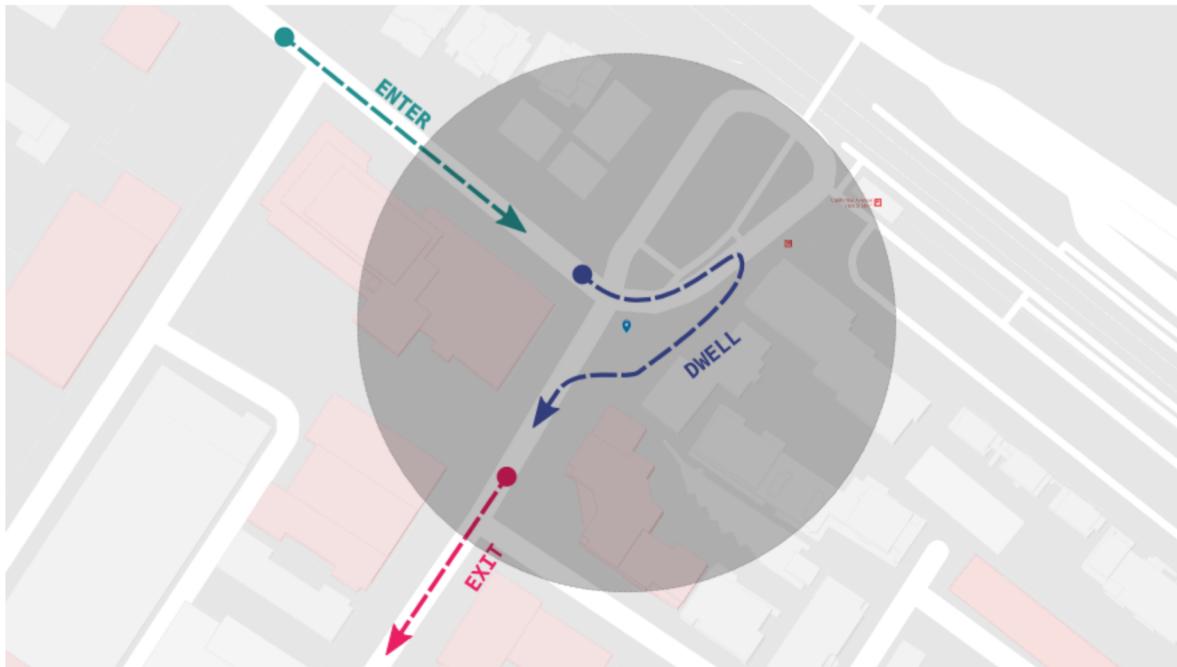
How to get location in Android – Option 3

- **Geofencing API**
 - Google Play Services
 - <https://developers.google.com/location-context/geofencing>
 - Geofencing API allows you to define perimeters
 - Your app gets a notification when the device crosses a geofence



Exercise

- Can you suggest 2 alternatives to geofencing without using Geofencing API or GPS?



Navigation is not only about GPS

- One of the consistent challenges when navigating with Google Maps is figuring out the right direction to go
- New approach for navigation with Global localization, which combines Visual Positioning Service (VPS), Street View, and Maps

Google Play Services APIs

- **Develop**
 - Awareness, Fit, Places
- **Grow**
 - Analytics
- **Earn**
 - Ads

API	Description in build.gradle
Google+	com.google.android.gms:play-services-plus:15.0.1
Google Account Login	com.google.android.gms:play-services-auth:16.0.0
Google Actions, Base Client Library	com.google.android.gms:play-services-base:15.0.1
Google Sign In	com.google.android.gms:play-services-identity:15.0.1
Google Analytics	com.google.android.gms:play-services-analytics:16.0.1
Google Awareness	com.google.android.gms:play-services-awareness:15.0.1
Google Cast	com.google.android.gms:play-services-cast:16.0.1
Google Cloud Messaging	com.google.android.gms:play-services-gcm:15.0.1
Google Drive	com.google.android.gms:play-services-drive:15.0.1
Google Fit	com.google.android.gms:play-services-fitness:15.0.1
Google Location and Activity Recognition	com.google.android.gms:play-services-location:15.0.1
Google Maps	com.google.android.gms:play-services-maps:15.0.1
Google Mobile Ads	com.google.android.gms:play-services-ads:15.0.1
Google Places	com.google.android.gms:play-services-places:15.0.1
Mobile Vision	com.google.android.gms:play-services-vision:15.0.2
Google Nearby	com.google.android.gms:play-services-nearby:15.0.1
Google Panorama Viewer	com.google.android.gms:play-services-panorama:15.0.1
Google Play Game services	com.google.android.gms:play-services-games:15.0.1
SafetyNet	com.google.android.gms:play-services-safetynet:15.0.1
Google Pay	com.google.android.gms:play-services-wallet:15.0.1
Wear OS by Google	com.google.android.gms:play-services-wearable:15.0.1

Google Fit APIs

- Sensor API
 - Raw sensor data access from both smartphone and wearables
- Recording API
 - Automated storage with subscriptions
- History API
 - Access to historical fitness data
- Sessions API
 - Store data/meta data of fitness activities
- Goals API
 - Tracking users fitness goals
- Bluetooth Low Energy API
 - Connect companion devices to Google Fit

<https://developers.google.com/fit/android/>

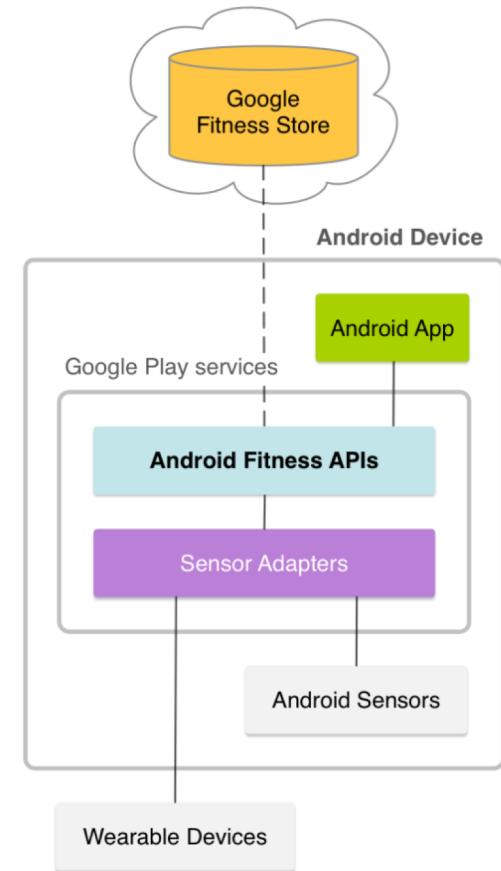


Figure 1: Google Fit on Android.

Awareness APIs

- **Fence API**
 - React to changes in the user's environment
 - The user's current location (latitude/longitude)
 - The user's current activity, like walking or driving.
 - Device-specific conditions, such as whether the headphones are plugged in.
 - Proximity to nearby beacons
- **Snapshot API**
 - Get an idea about user's current environment using 7 sensor inputs
 1. Time
 2. Location
 3. Place
 4. Activity
 5. Beacons
 6. Headphones
 7. Weather
- **Have fun developing “Context-Aware” apps...!**
- <https://developers.google.com/awareness/>



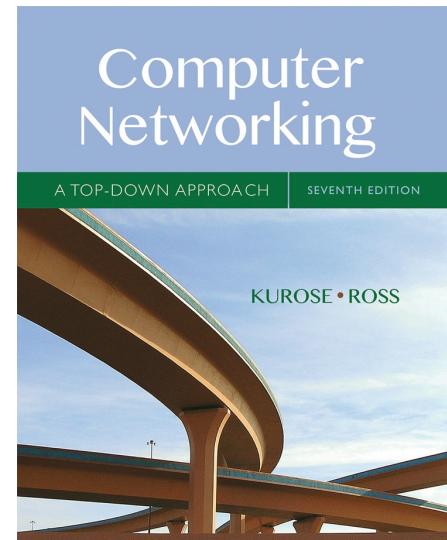
What' Next ?

- **Start working on Project Proposal**
 - Due in week 6.
- **Tutorial 4**
 - Learn how to develop mobile app using Google's Firebase platform
 - Understand how to use Cloud Firestore to store and read data
- **Next week**
 - How to respect and effectively manage Mobile Networking resources when you develop apps?

Optional Internet Protocols- Basics

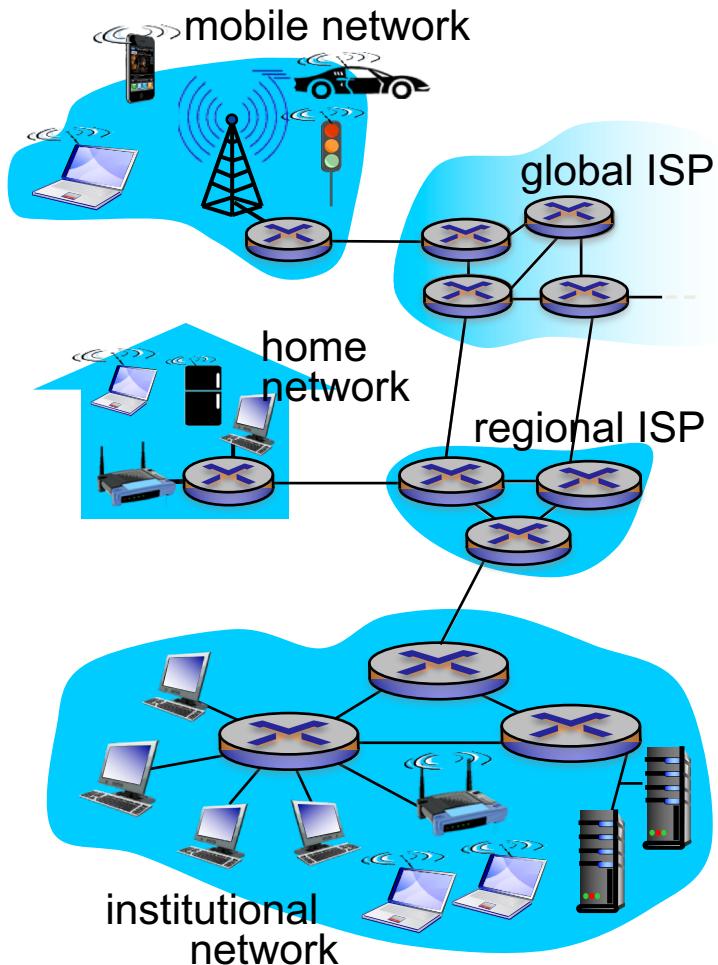
These slides are adopted from

- **Computer Networking: A Top Down Approach**
7th Ed. Jim Kurose, Keith Ross
Pearson - Addison-Wesley



What is Internet ?

- Billions of connected computing devices
 - Communication links
 - Fiber, copper, radio, satellite
 - Hosts – end devices
 - User devices, Servers
 - Packet Switches
 - Routers, Switches
- To inter-operate, we need;
 - Protocols
 - TCP, IP, HTTP, 802.11
 - Standards
 - RFC
 - IETF



What is a Protocol ?

human protocols:

- “what’s the time?”
- “I have a question”
- introductions

... specific messages sent

... specific actions taken
when messages received,
or other events

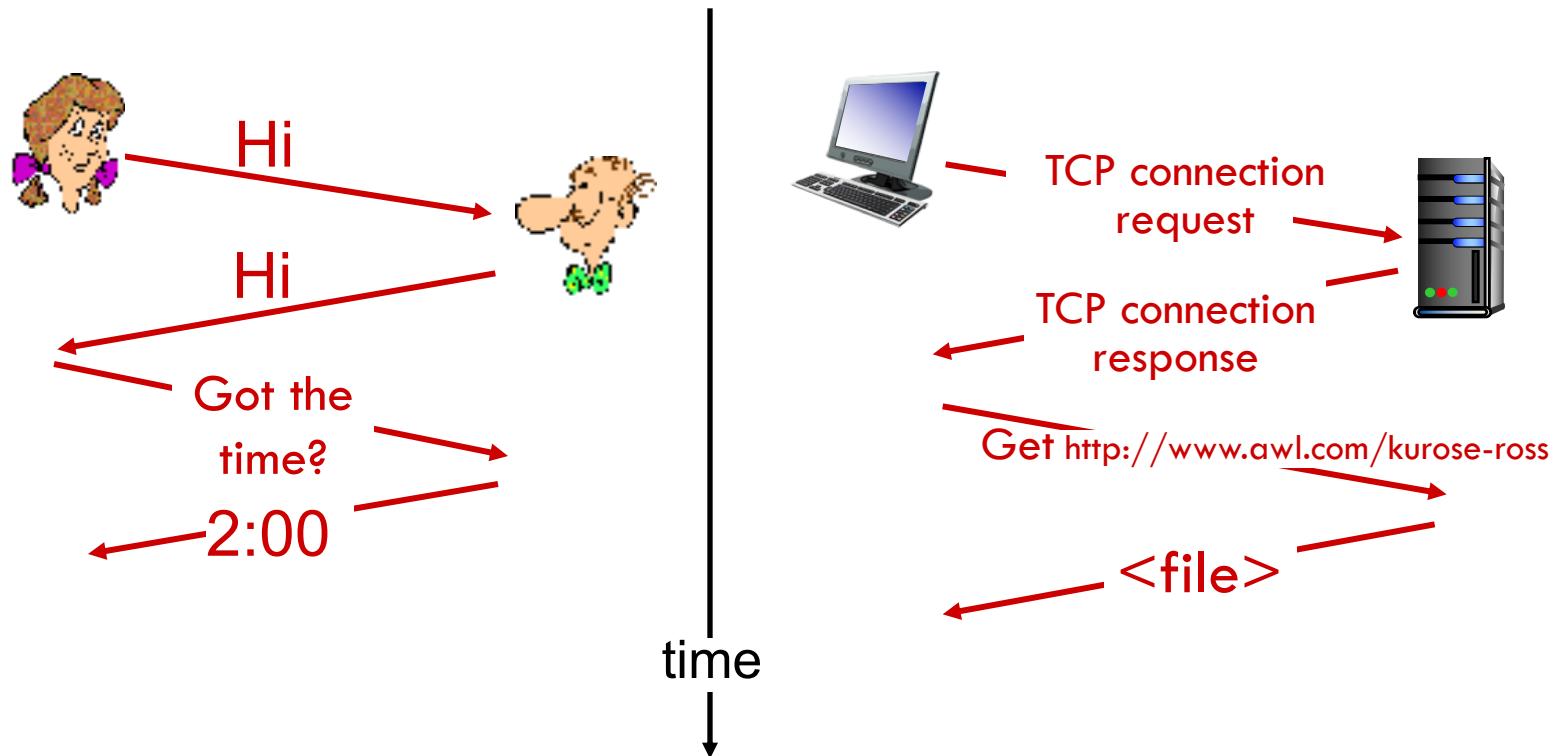
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, receipt

What is a protocol ?

a human protocol and a computer network protocol:



Transport Service Requirement

application	data loss	throughput	time sensitive
file transfer	no loss	elastic	no
e-mail	no loss	elastic	no
Web documents	no loss	elastic	no
real-time audio/video	loss-tolerant	audio: 5kbps-1Mbps video: 10kbps-5Mbps	yes, 100's msec
stored audio/video	loss-tolerant	same as above	yes, few secs
interactive games	loss-tolerant	few kbps up	yes, 100's msec
text messaging	no loss	elastic	yes and no

Common Internet Protocols

application	application layer protocol	underlying transport protocol
e-mail	SMTP [RFC 2821]	TCP
remote terminal access	Telnet [RFC 854]	TCP
Web	HTTP [RFC 2616]	TCP
file transfer	FTP [RFC 959]	TCP
streaming multimedia	HTTP (e.g., YouTube), RTP [RFC 1889]	TCP or UDP
Internet telephony	SIP, RTP, proprietary (e.g., Skype)	TCP or UDP

TCP and UDP

TCP service:

- *reliable transport* between sending and receiving process
- *flow control*: sender won't overwhelm receiver
- *congestion control*: throttle sender when network overloaded
- *does not provide*: timing, minimum throughput guarantee, security
- *connection-oriented*: setup required between client and server processes

UDP service:

- *unreliable data transfer* between sending and receiving process
- *does not provide*: reliability, flow control, congestion control, timing, throughput guarantee, security, or connection setup,

Q: why bother? Why is there a UDP?

Securing TCP

TCP & UDP

- no encryption
- cleartext passwords sent into socket traverse Internet in cleartext

SSL

- provides encrypted TCP connection
- data integrity
- end-point authentication

SSL is at app layer

- apps use SSL libraries, that “talk” to TCP

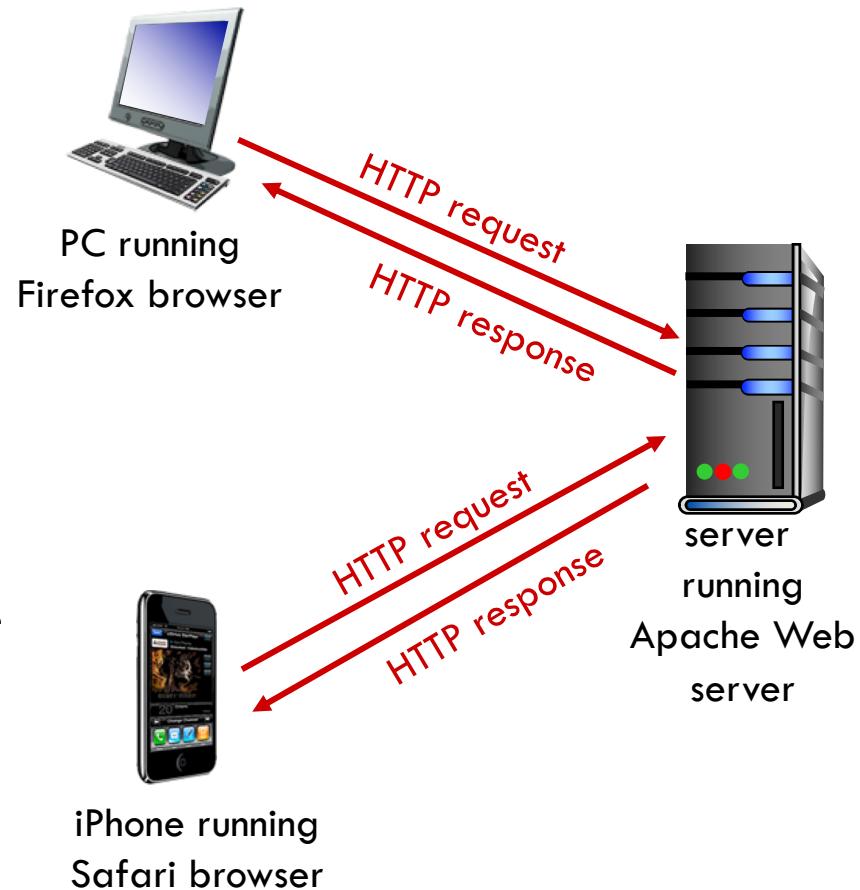
SSL socket API

- cleartext passwords sent into socket traverse Internet encrypted
- see Chapter 8

HTTP Overview

HTTP: hypertext transfer protocol

- Web's application layer protocol
- client/server model
 - **client:** browser that requests, receives, (using, HTTP protocol) and “displays” Web objects
 - **server:** Web server sends (using HTTP protocol) objects in response to requests



HTTP overview

uses TCP:

- client initiates TCP connection (creates socket) to server, port 80
- server accepts TCP connection from client
- HTTP messages (application-layer protocol messages) exchanged between browser (HTTP client) and Web server (HTTP server)
- TCP connection closed

HTTP is “stateless”

- server maintains no information about past client requests

aside

protocols that maintain “state” are complex!

- past history (state) must be maintained
- if server/client crashes, their views of “state” may be inconsistent, must be reconciled

Web and HTTP

- web page consists of *objects*
- object can be HTML file, JPEG image, Java applet, audio file,...
- web page consists of *base HTML-file* which includes *several referenced objects*
- each object is addressable by a *URL*, e.g.,

www.someschool.edu/someDept/pic.gif

host name

path name

HTTP Method Types

HTTP/1.0:

- GET
- POST
- HEAD
 - asks server to leave requested object out of response

HTTP/1.1:

- GET, POST, HEAD
- PUT
 - uploads file in entity body to path specified in URL field
- DELETE
 - deletes file specified in the URL field

HTTP Request Message

- two types of HTTP messages: *request, response*
- **HTTP request message:**
 - ASCII (human-readable format)

request line
(GET, POST,
HEAD commands)

header
lines

carriage return,
line feed at start
of line indicates
end of header lines

```
GET /index.html HTTP/1.1\r\n
Host: www-net.cs.umass.edu\r\n
User-Agent: Firefox/3.6.10\r\n
Accept: text/html,application/xhtml+xml\r\n
Accept-Language: en-us,en;q=0.5\r\n
Accept-Encoding: gzip,deflate\r\n
Accept-Charset: ISO-8859-1,utf-8;q=0.7\r\n
Keep-Alive: 115\r\n
Connection: keep-alive\r\n
\r\n
```

carriage return character
line-feed character

* Check out the online interactive exercises for more
examples: http://gaia.cs.umass.edu/kurose_ross/interactive/

HTTP Response Message

status line
(protocol
status code
status phrase)

header
lines

data, e.g.,
requested
HTML file

```
HTTP/1.1 200 OK\r\n
Date: Sun, 26 Sep 2010 20:09:20 GMT\r\n
Server: Apache/2.0.52 (CentOS)\r\n
Last-Modified: Tue, 30 Oct 2007 17:00:02
GMT\r\n
ETag: "17dc6-a5c-bf716880"\r\n
Accept-Ranges: bytes\r\n
Content-Length: 2652\r\n
Keep-Alive: timeout=10, max=100\r\n
Connection: Keep-Alive\r\n
Content-Type: text/html; charset=ISO-8859-
1\r\n
\r\n
data data data data data ...
```

* Check out the online interactive exercises for more
examples: http://gaia.cs.umass.edu/kurose_ross/interactive/

HTTP response status codes

- status code appears in 1st line in server-to-client response message.
- some sample codes:

200 OK

- request succeeded, requested object later in this msg

301 Moved Permanently

- requested object moved, new location specified later in this msg (Location:)

400 Bad Request

- request msg not understood by server

404 Not Found

- requested document not found on this server

505 HTTP Version Not Supported