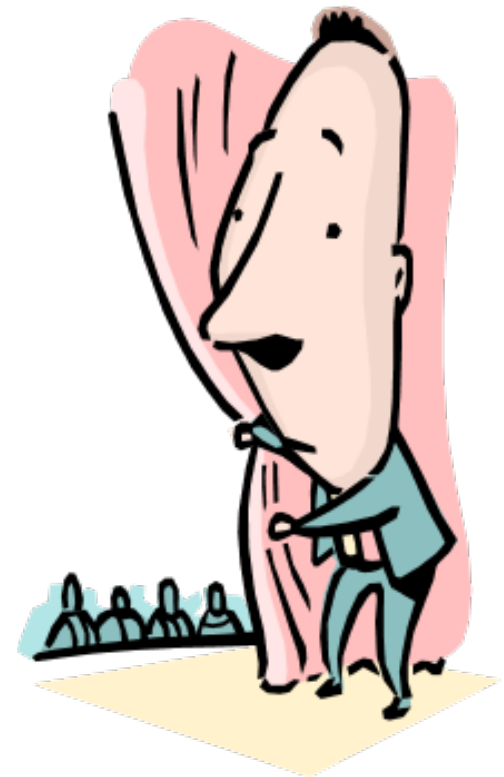


Location Based Services: From Promise to Reality

Ravi Jain
and Google LBS Team
10 Sep 2008



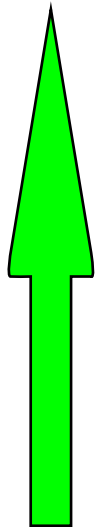
Outline

- Introduction
- Determining Geographical Location
- My Location from Google
- Location-Based Services
- Summary

Types of locations and services

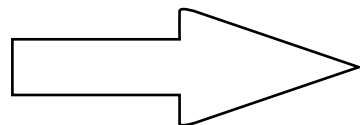
- Location Based Service:
 - An end-user service that provides information or value based on the user or device's location
- Location Service:
 - A service that provides the location
- Descriptive location or tag:
 - Public: "Woodside Mall", or Personal: "My house"
- Street address: "123 Main St"
- **Geographical location: lat/long**
- Network location: Cell ID, IP address

More abstract

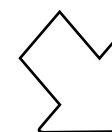


Determining geographical location

RF
measurement

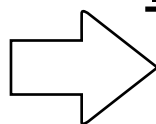


RF to Geo:
RF methods
(TDoA etc)
RF fingerprinting
GPS / AGPS

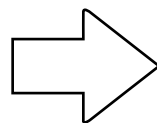


Geo location:
Lat/Long

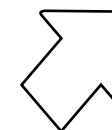
Network
info



Network
location:
Cell ID
WiFi
IP



Network to Geo
conversion



Location Technologies: Accuracy

- ~ 1 - 50 m
 - RFID
 - Sonar / Ultrasound
 - GPS, AGPS
 - WiFi-Network positioning e.g. RADAR
 - Bluetooth
- ~ 50 - 500 m
 - WiFi AP ID
 - Cellular-Network positioning e.g. for E-911
- ~ 500m - 5 km
 - Cell ID
- 5 km +
 - IP address

Location Technologies: Selection Criteria

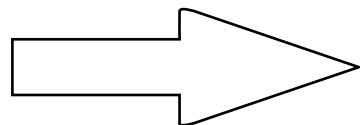
- Accuracy is not the only dimension
- Other criteria
 - Coverage:
 - Indoor vs outdoor
 - National vs regional vs local
 - Time to first fix
 - Power consumption
 - CPU and bandwidth requirements
 - Infrastructure: New deployment vs reuse existing
 - Freshness: wardriving, calibration, or download
 - Cost
- No one technology satisfies all criteria

Outline

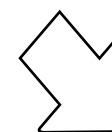
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Determining geographical location

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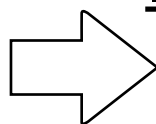


RF to Geo:
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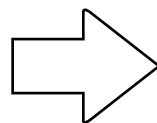


Geo location:
Lat/Long

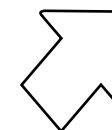
Network
info



Network
location:
Cell ID
WiFi
IP

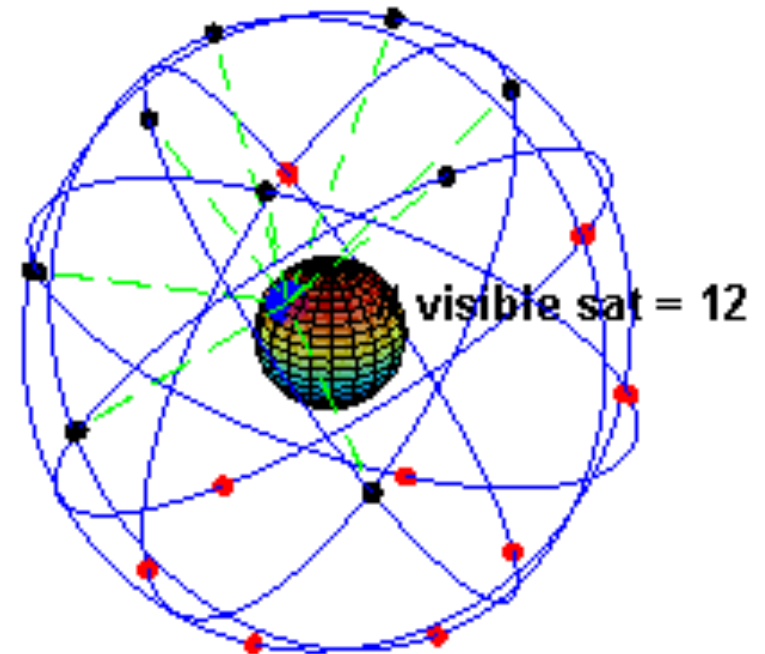
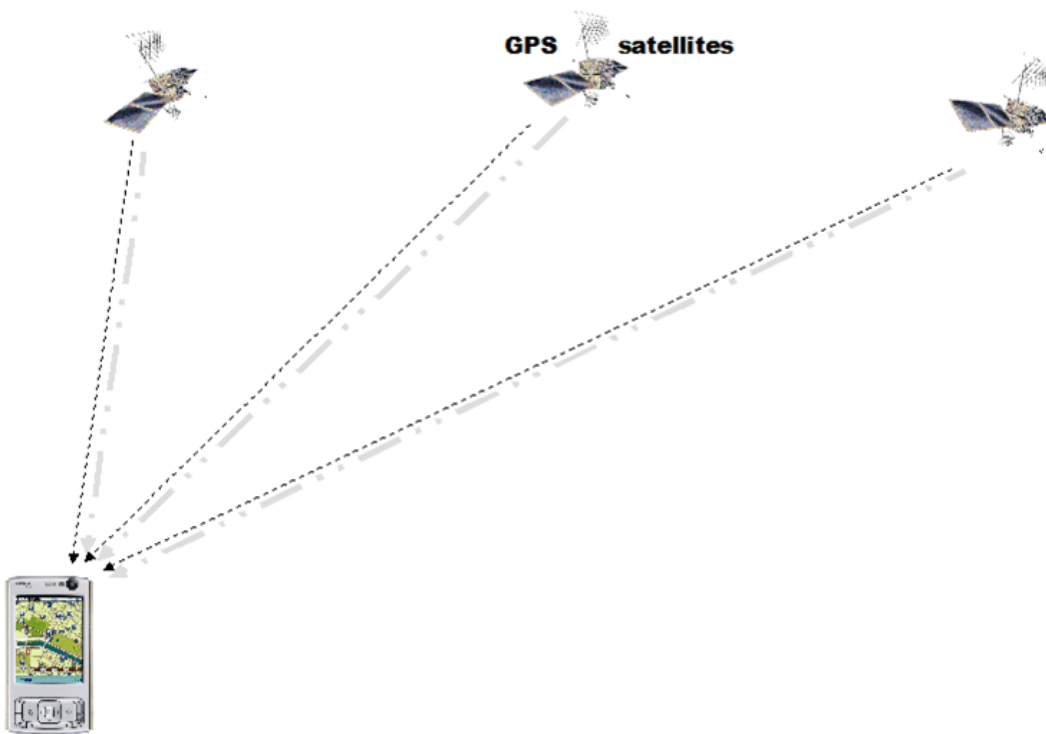


Network to Geo
conversion



Geographic Location: GPS Basics

- Six planes with four satellites each
- Orbits arranged so at least 6 satellites are always within line of sight from almost everywhere on Earth's surface.



GPS Signals

- **GPS orbit data:**

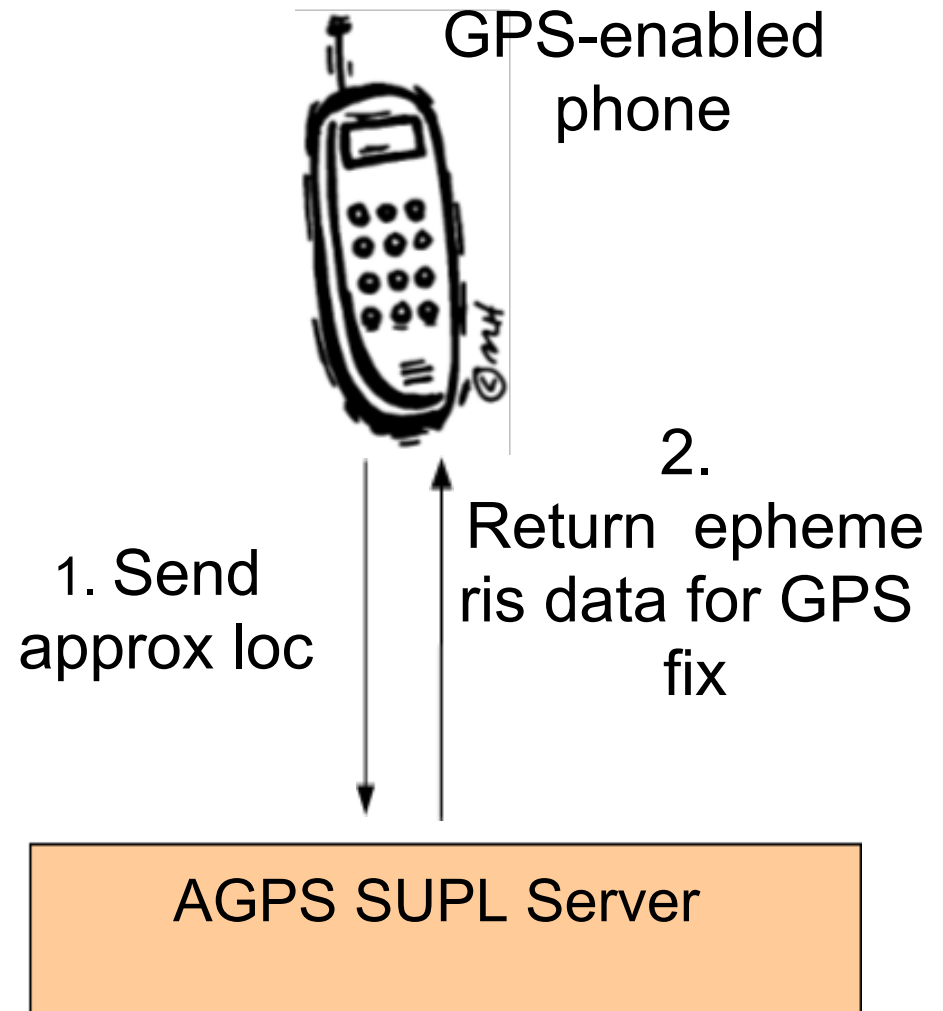
- **Almanac** (coarse, long-term orbit info). This tells your receiver what to “listen for”.
- **Ephemeris** (precise, current orbit info.)

-

- *Weak* : (-13-dBm) == 0.5w baby monitor 1000 miles away
- *Slow* : 50 bits/s. To obtain the data
 - Ephemeris: 20 sec.
 - Entire almanac from a single satellite: 12.5 minutes
- *Noisy* . Ionospheric effects, Ephemeris errors , Satellite clock errors, Multipath distortion, etc.

Assisted GPS

- Assisted GPS combines the accuracy of GPS with much greater speed
- SUPL is standards-based AGPS protocol

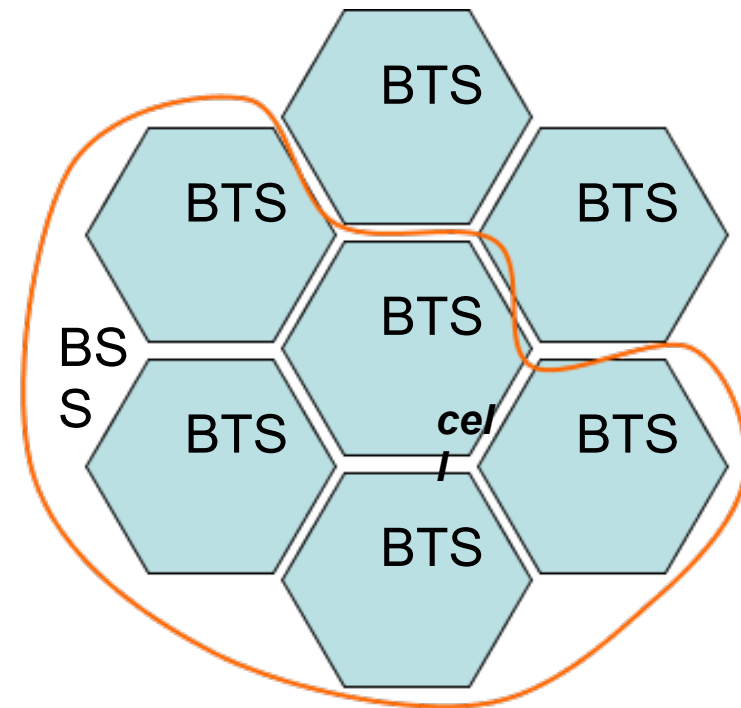


AGPS Benefits

1. Significantly improves GPS time to first fix.
 - TTFF is < 10 second with assistance and > 60 seconds without assistance
2. Less computation on the handset - less battery drain.
3. Higher accuracy.
4. Supports E-911 (in SUPL Network Initiated mode).

Network location: Cell Id

- Cellular networks consist of radio cells of various size
 - Rural – up to 30km
 - Suburban – up to a few kilometers
 - Urban – 100's of meters
 - Femtocell – residential home
- Phone attaches to cell with strong signal
- Hence, cellid-based localization
 - Uses physical footprint of cell to estimate handset location
 - Accuracy: a few 100m to few km



BTS – base transceiver station
BSS – base station subsystem
BSC – base station controller

Why is it useful?

- Complements GPS solution
 - *Fast*: no waiting for time-to-first-fix
 - *Reliable*: where GPS suffers in indoor or urban canyon
 - *Power-friendly*: enhance battery lifetime
- Across the “walled garden”
 - Carrier agnostic
 - No country barrier
 - Works with all cellular technologies
- Lower accuracy ≠ showstopper
 - Many applications need only coarse location
 - Feeds Assisted GPS (AGPS)

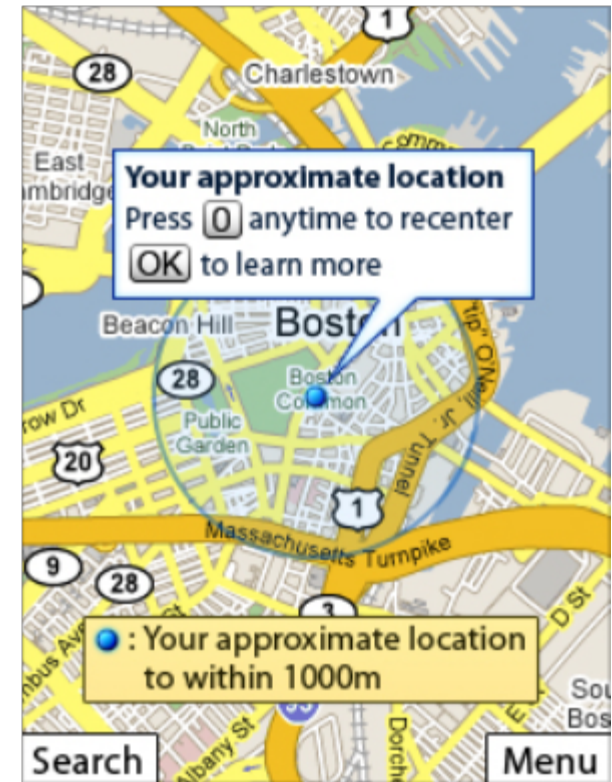
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Google Maps for Mobile w/ My Location

"Think of it as a road atlas which always opens to the right page"

- Launched Nov '07 industry's first global cell tower location database
- Location without GPS
- Global cell tower-based location
 - 200+ supported countries
 - 200+ carriers
 - 2G, 3G, CDMA
- Phones supported
 - Blackberry
 - Windows Mobile
 - Symbian
 - SonyEricsson
 - iPhone
 - Palm Centro
 - Android

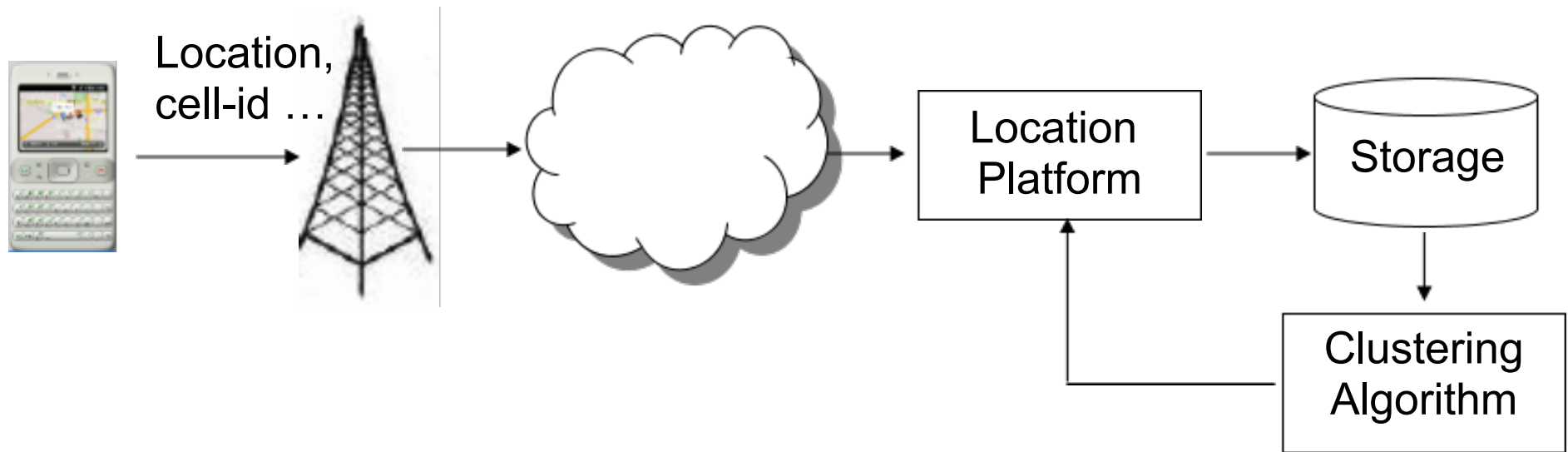


Privacy

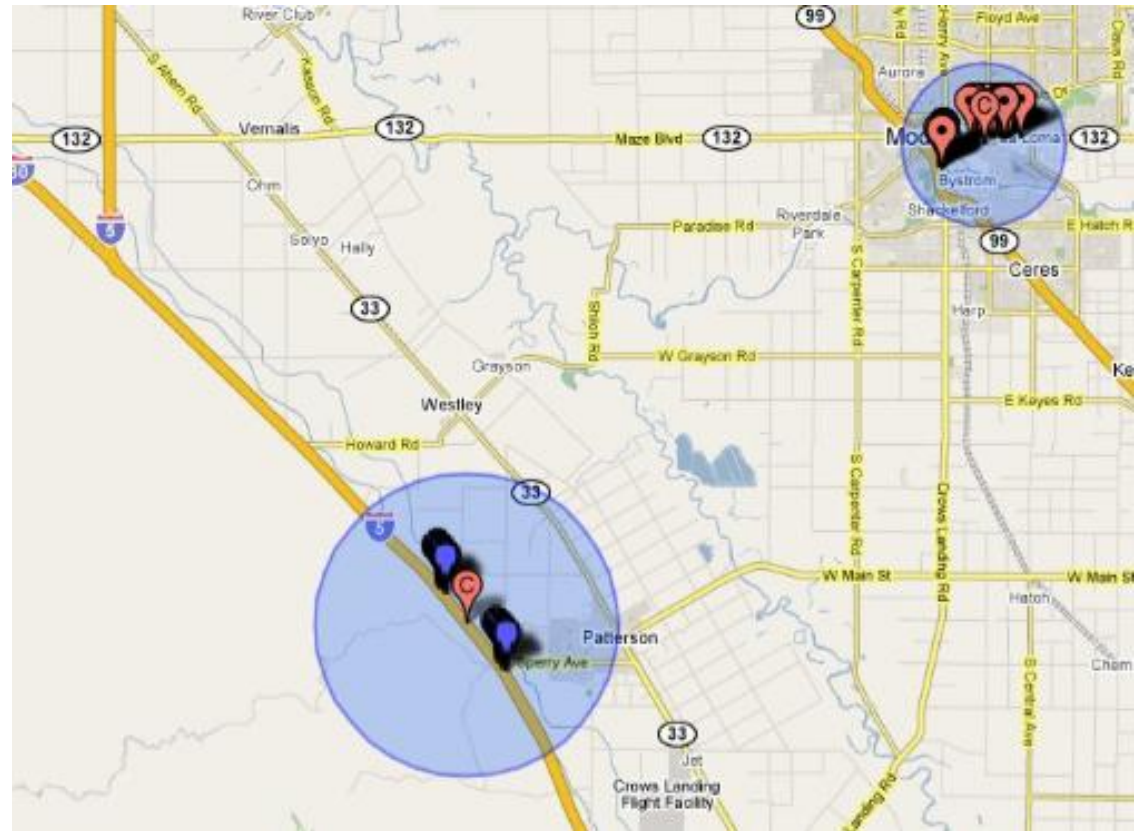
- A balance between respecting user privacy and providing good useful functionality to the user
- How does My Location do this?
 - Anonymous: No user login
 - User has full control
 - User is informed
 - Communication, Privacy policy, User education (via Help, You Tube videos, etc), Outreach

Behind The Scenes

- Collect geocontextual information along with a **cell-id**
- Cell Tower Identifier (**cell-id**)
- Location: GPS vs. center of the map



Clustering Algorithm



- GPS Clustering Vs. non-GPS
- Use data diversity to calculate accuracy

Challenges

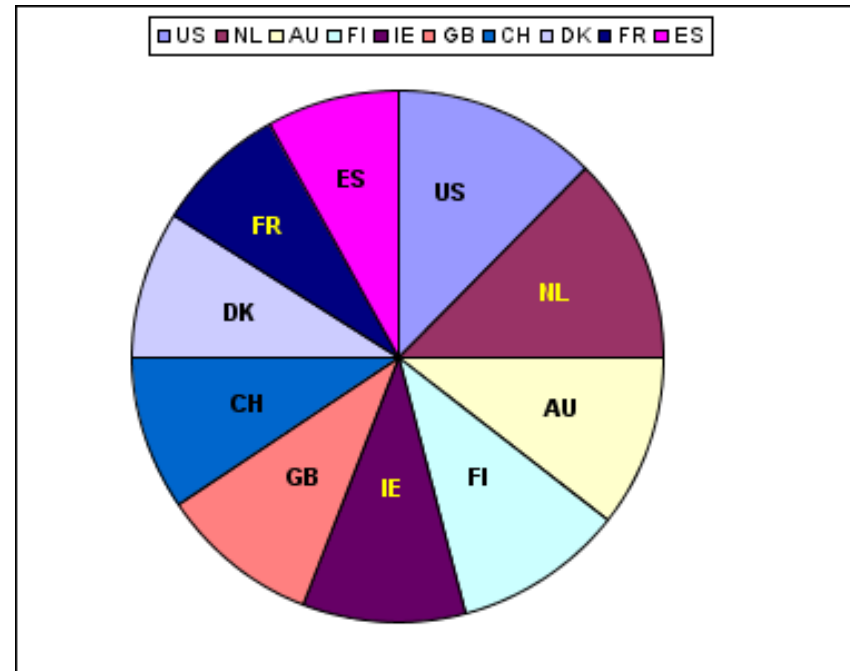
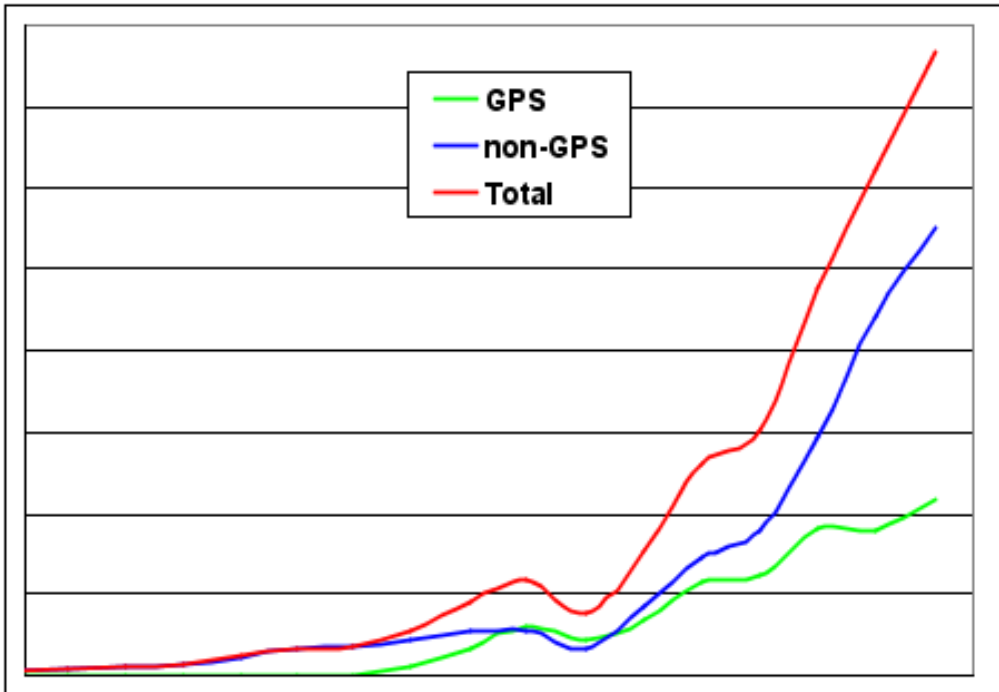
- Area of interest vs. actual location
- Noisy data:
 - Oklahoma points
 - GPS errors
- Towers in the water!

Platform Support

Hey, My Location seems very cool but why is it not working on my cell phone?



Data Collection



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My Location Timeline



Google Maps for mobile v2.0



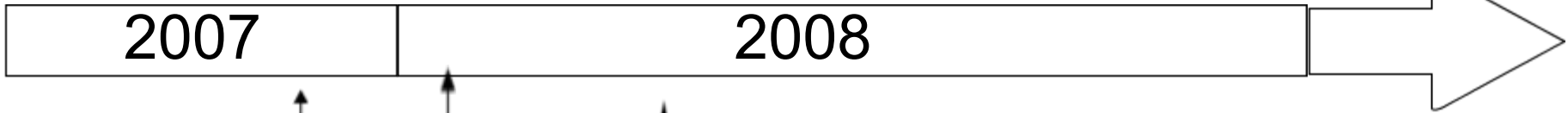
Android SDK w/ Location



My Location Timeline



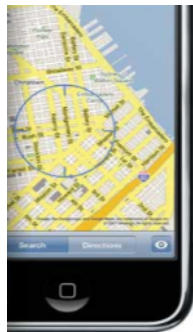
Google Maps
for mobile v2.0



Android SDK w/ Location



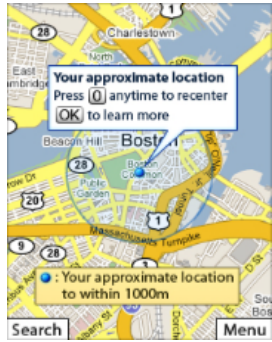
Google Maps on iPhone



Google Gears
Location API



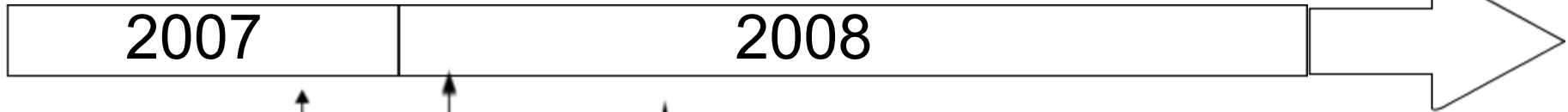
My Location Timeline



Google Maps for mobile v2.0



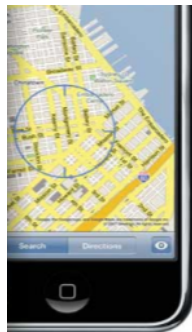
iPhone SDK



Android SDK w/ Location



Google Maps on iPhone



Google Gears Location API



My Location Timeline



Google Maps for mobile v2.0



iPhone SDK



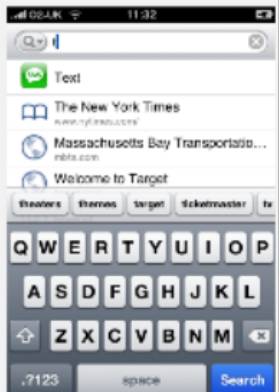
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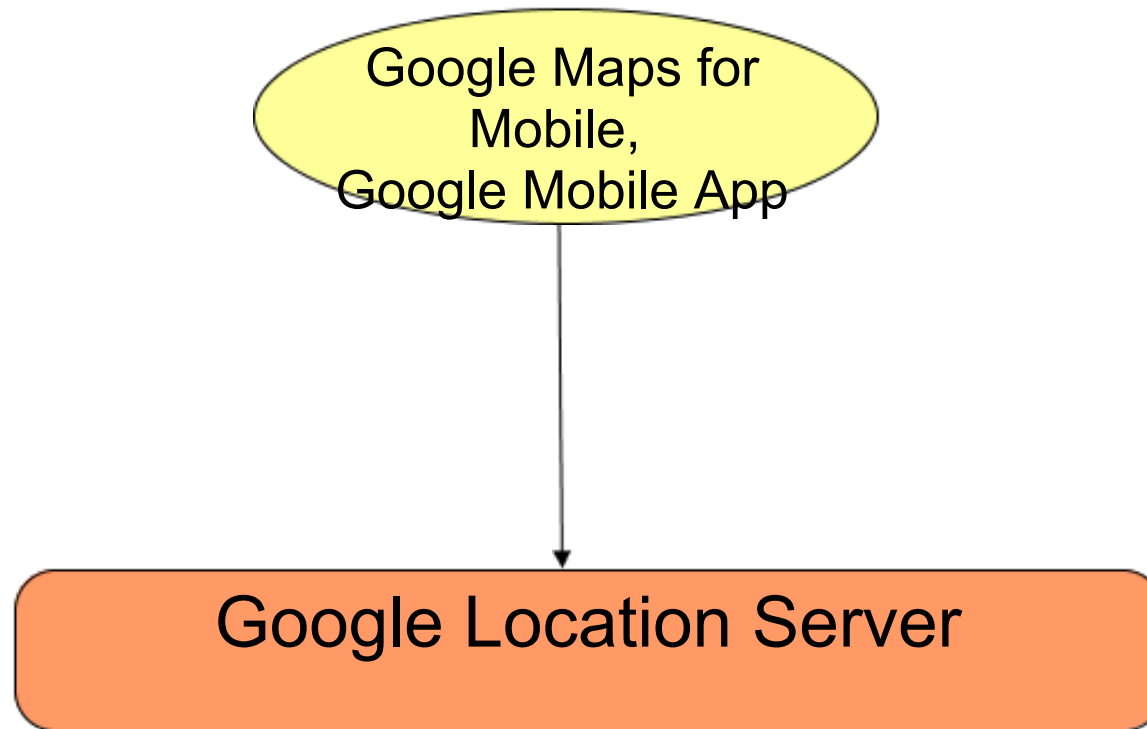


Google Mobile App



Location Based Applications

- Google Maps for Mobile

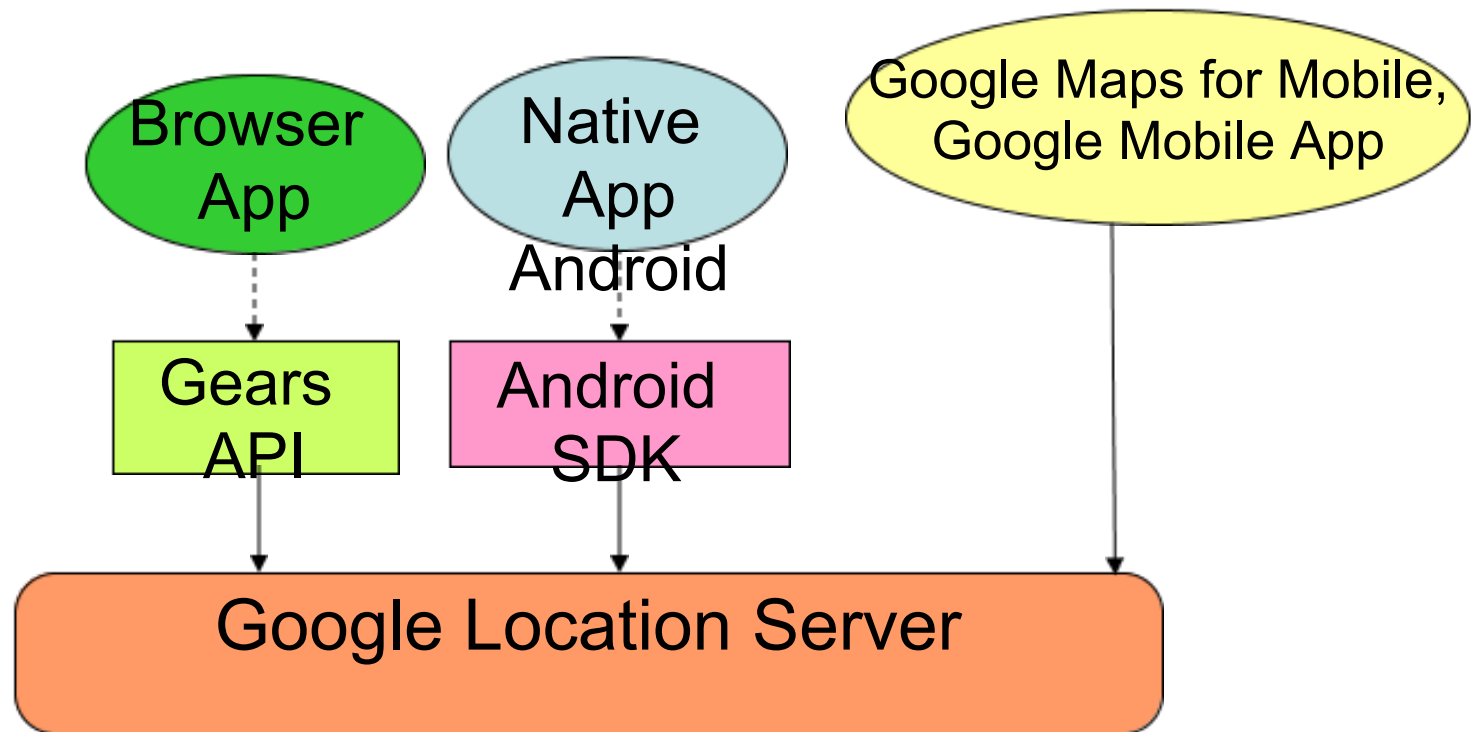


Location Based Applications

- The location of a wireless device such as a cellphone is always known, to some degree of accuracy
- The challenge is: how can an application get access to it?
- Options
 - Access on-board geographical location information directly e.g. from GPS, AGPS
 - Access a network location and convert to geographical location e.g. Cell ID, WiFi access point, IP address
- In either case, some API is required
 - Native device API
 - Abstract device-independent API e.g. J2ME JSR 179
 - Browser-based API

The Coming Wave

Enabling location for 3rd parties via:
Android, iPhone, Gears (browser)



Gears JavaScript API

- One-shot position requests
 - for recommendations sites -- "where am I right now?"
- Repeated position updates
 - for continuously updating one's location on a map
- Ability to get the last-known position
 - but cheaply before doing an expensive new request

Gears JavaScript API Interface

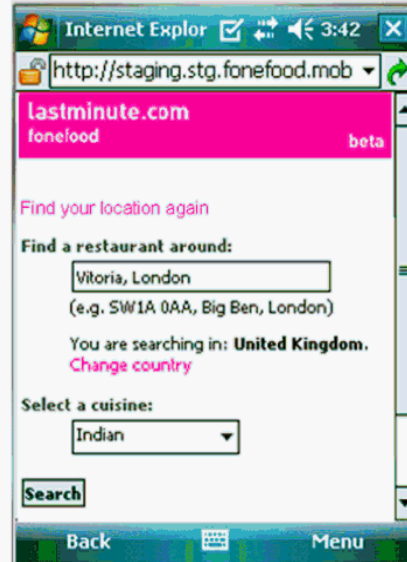
```
interface Geolocation {  
    readonly Position lastPosition;  
  
    void getCurrentPosition(function successCallback,  
                            function errorCallback,  
                            optional PositionOptions options);  
  
    int watchPosition(function successCallback,  
                      function errorCallback,  
                      optional PositionOptions options);  
  
    void clearWatch(int watchId);  
};
```

3rd Party Apps - lastminute.com

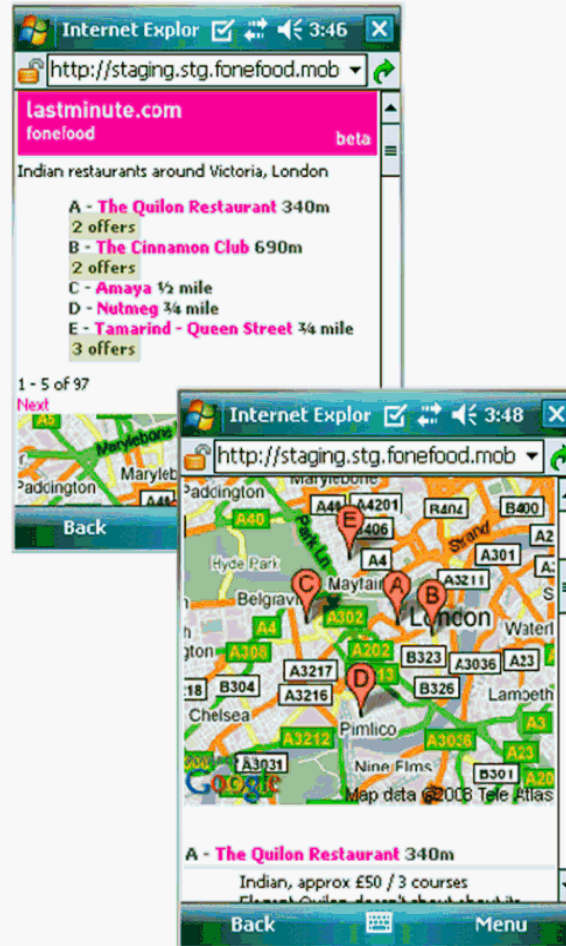
Start Page



Location Found



Results



1. Click "Find your location"
2. (Optionally) Select a cuisine
3. Click Search

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Summary

- LBS is finally becoming a reality
 - Critical factors converging
 - Location technology, device and network capabilities
 - Diminishing costs
 - Emerging applications
- Google My Location Service
 - Powering Google apps
 - Providing APIs
- Issues and challenges
 - Diversity of location technologies
 - Proven business models
 - Innovative apps

How can you help?

Build **innovative** location-based applications

THANK YOU



<http://www.google.com/gmm>

<http://code.google.com/android/>

<http://code.google.com/apis/gears/>