Location Based Services:
From Promise to Reality

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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
Determining geographical location

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

Network location:
- Cell ID
- WiFi
- IP

Network to Geo conversion

Geo location: Lat/Long
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

● Introduction
● **Determining Geographical Location**
● My Location from Google
● Location-Based Services
● Summary
Determining geographical location

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Network info → Network location:
- Cell ID
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Network to Geo conversion

Geo location: Lat/Long
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.

1. Send approximate location to AGPS SUPL Server.
2. Return ephemeris data for GPS fix.

GPS-enabled phone connected to AGPS SUPL Server.
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.
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, celldid-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!
Hey, My Location seems very cool but why is it not working on my cell phone?

Platform Support

- None
- Partial
- Good
- Full

Some WinMo devices (e.g. Samsung, MotQ, Palm Treo 700w)

BB V4.0

BB V4.2

neighbor information, average RSSI, TA
Data Collection
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My Location Timeline

Google Maps for mobile v2.0

Android SDK w/ Location
My Location Timeline

2007

Android SDK w/ Location

2008

Google Maps for mobile v2.0

Google Maps on iPhone

Google Gears Location API

Google Maps
My Location Timeline

- 2007
  - Android SDK w/ Location
  - Google Maps on iPhone

- 2008
  - iPhone SDK
  - Google Maps for mobile v2.0
  - Google Gears Location API
  - Google Gears
Location Based Applications

- Google Maps for Mobile

Diagram:
- Google Maps for Mobile, Google Mobile App
- Google Location Server
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
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

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

http://www.google.com/gmm
http://code.google.com/android/
http://code.google.com/apis/gears/