

# Location, Location, Location

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# Outline

- Positioning Technology
  - GPS and others
- Location Specifiers
- Privacy Issues



# Universal Location

- On earth, we need three piece of information:
  - latitude, longitude, & altitude
  - there are other possibilities
- Global Positioning Systems can give us that information
- Can then use mapping to do something useful with that information



# Global Positioning Systems

- 1978 US Department of Defense begins project
- 1984 Crash of Korean Flight due to poor navigational equipment ==> gps for civilian use
- 1985 Complete system fully operational
  - 24 satellites (11,000 mile orbit) & \$12 billion
- 2000, selective availability turned off
  - 3 to 15 meter accuracy for everyone

# How it works

- Receiver measures travel time of random code sent from satellite (about 0.1 sec)
  - compute distance, call it  $X$
- Receiver's position can be anywhere on a sphere of radius  $X$  with satellite at center
- Given four satellite readings, can figure out position in 3 dimensions
- Let's look at some government slides
  - [mms.nps.gov/gis/gps/How\\_GPS\\_Works.ppt](http://mms.nps.gov/gis/gps/How_GPS_Works.ppt)



# GPS

- Python interface to a bluetooth gps
- Connect to the GPS normally:
- from socket import \*
- sock = socket(AF\_BT, SOCK\_STREAM)
- Read input from ‘\$’ up to a ‘\r’ character using the sock.recv(1) command (reading one byte at a time).



# GPS (cont)

- buf = sock.recv(1)
- while buf != '\$': buf = sock.recv(1)
- while buf[-1] != '\r':buf += sock.recv(1)
- if buf[0:6] == "\$GP GGA":
  - (GPGGA, utcTime, lat, ns, lon, ew, postfix, sats, hdop, alt, altunits, sep, sepunits, age, sid) = buf.split(',')
    - latitude = float(lat)
    - longitude = float(lon)



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Please see:

<http://home.pacific.net.au/~gnb/gps/mnea.html>

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# GSM Cellular location

- GSM mobile telephone network: cells
  - towers fixed, signal available indoors
  - unaffected by “urban canyon effect”
- CellID: detect base transceiver stations (BTS)
  - phone is registered with a BTS
  - usually, but not always, the closest one



# GSM Cellular Location

- Cell size depends on terrain & number of users
- Error: about 500 m (urban) to 15km (rural)
- Base stations have 3 antennas, 120 degree sectors

# Enhanced Method

- E-OTD: Enhanced observed time difference
- Time from base station to phone
- Time from base station to fixed location
  - Ratio gives better estimation of position
- Also use triangulation (from several bases)
- Both yield order of magnitude improvement
  - and lots of research for even better results

# What good is GPS?

- It is universal
- But is it what we want?
- Human-centric versions of location:
  - name of place
  - map of place



# Other Data Formats

- Geographic Information System (GIS)
  - developed set of XML descriptions
    - static (river): Geo Markup Language
    - dynamic (cars, events): Point-of-interest
- NVML: Navigation mark-up language
- SKiCAL: iCalendar VEVENT used to describe event information
  - event meta-info: location



# Spatial Databases

- Set of functions to
  - quickly search, query, analyze spacial info
  - how objects spatially relate to each other
  - many geometry types and typical queries



# People don't speak GPS

- Different people have different views of the world.



# Places -- big and small

- People refer to location as places
  - countries, cities, towns, streets, buildings
  - rooms, spaces within buildings
  - relation to other places,
    - e.g. across from Starbucks
- GPS is too precise and may require accurate map or building plan
- Jim might be at 42.3325N, -71.11861E but is he in the shower at the moment?



# Location Tracking: Good, Bad, or Ugly?

- Not too many people seem to be concerned about location-based services tracking them.
- “**You have no privacy, get over it**”
  - Scott McNealy, CEO Sun

# Can we study this?

- Before investing heavily in location-based services, we should find out if people will use them.
- The evidence is still mixed



Service	Description
Service A: Ringing profiles in private settings	The mobile phone 'knows' when the user is in a meeting or in class
Service B: Ringing profiles in public settings	The mobile phone 'knows' when the user enters a movie theater or a restaurant
Service C: Lunch service	A suggestion for lunch is pushed by the retailer to the mobile phone when the user is around a restaurant or fast food place
Service D: Localization of predefined friends	The mobile phone can locate predefined friends and alert the user when they are within a certain distance
Location-Based Services.	

Service	Rated usefulness	Rated Intrusiveness	Average# of daily use
Service A: Private ringing profiles	3.75	2.1	1.5
Service B: Public ringing profiles	2.6	2.2	0.4
Service C: Lunch service	2.2	3.7	0.3
Service D: Localization of predefined friends	3.75	3.25	1.3

1 = not useful at all, 5 = very useful

1 = not intrusive, 5 = very intrusive

## AVERAGE RATING OF THE SERVICES

Figure by MIT OCW.

Services	Personalization	Passive Context-Awareness	Active Context-Awareness
A: Private ringing profiles	Different ringing profiles that are set manually	The phone prompts the user to adjust the profile when sensing it is in a meeting or class	The phone automatically changes profile when sensing the user is at a meeting or in class
B: Public ringing profiles	Different ringing profiles that are set manually	The phone prompts the user to adjust the profile when sensing it is in a movie theater or at a restaurant	The phone automatically changes profile when sensing the user is at a movie theater or at a restaurant
C: Lunch service	Manual search for appropriate lunch place	Single alert around noon for lunch place according to user's preferences	Alerts the user when passing by a lunch place or relevance and suggests places at noon.
D: Class slides	Manual search to see if class slides are available online	If signed up, the phone alerts user of available slides for class	Automatic alert every time the teacher updates class slide website
E: Location tracking	Manual location tracking of predefined friends	Locations tracking of friends and setting to alert when they are within a certain range	Location detection of friends that alerts when they are within 300 feet of user
F: Activity tracking	Display of potential call-receiver's social situation (e.g. meeting, home, out)	In a new context, the phone prompts the user to display the user's situation to possible callers	Automatic switch to display of social situation when entering a new context

The three levels of services presented to participants.

# Does Age Matter?

- Not much in this sample of 23 participants.
- surprising result

N = 23	Personalization	Passive Context-Awareness	Active Context-Awareness
N	8	8	7
Average Age	23.7	22.9	25
Average Mobile Phone Ownership	2.2 Years	2.6 Years	2.7 Years
Average User Level ( a scale from 1-6)	3.1	3.8	3.4
General participant demographics.			

# Their Conclusions

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