Location Again

Location API’s and Room-Size Location
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GPS & Cell Location

A-GPS PRINCIPLES

Figure by MIT OCW.
Location Server’s Location

• Where should the server be located?
  • On handset
    • Respond to inquires about location with option to deny
    • When handset lost or disconnected, cannot find it.
  • In network
• Privacy concerns
Client’s Role

• Ask server for location of handset
  • Must know how to contact handset
  • Long round-trip, so done asynchronously

• How to ensure privacy?
  • emergency call --> always allow
  • ask server’s owner
    • when and how often?
What information?

• Current position (Cell or GPS or Other)
• How current? How precise?
• Request periodic updates
• what happens when client disconnects
• Heading and orientation information
• Waypoints (and associated notes)
• Lots of competing systems
• J2ME, Symbian, and each operator
Lots more details

- Time, angle of arrival, speed, acceleration
- Type of location technology specs
  - number of satellites, cell towers, weather
  - pitch, roll, magnetic compass quality
- My strategy:
  - first list all information you think is important and then check with standard
How to spoof

• Borrow friends phone
• register it with tracking service (TS)
• TS sends msg to phone for confirmation
• Answer msg, delete it, return phone
• No need to borrow phone if know phone ID
• when phone is turned off, put its ID into a different phone, do the above steps, and then turn off.
Larry’s Location Larceny

- How to foil tracking -- even when cell towers know your phone’s location
- Switch ID’s when near each other when
- Alice and Bob realize they’re in same cell

Figure by MIT OCW.
Assumptions

• Phone can forward calls to another phone
• Phones can change their ID (also #, IP)
• Can detect ID & # of incoming call
• Can detect cell tower connection
• Can connect to any of a set of servers
LLL (cont)

• Alice & Bob switch

• When looking for Bob, you find Alice, and she forwards call to Bob.

• Bob accepts calls forwarded from Alice (the calls look like they came from Bob)

• Bob forwards all other call to Alice

• Bob and Charlie switch

• Look for Bob, find Alice who forwards to Charlie who forwards to Bob
Graph View of LLL

- Nodes always in some cycle
- Forward thru whole cycle

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Bookkeeping View

• When switching, just exchange current id info

• How to know when to stop forwarding?
Inverse links

• If a node is shut off rest will be unreachable

• Use servers to deal with reverse links

• Node chooses server at random, if two nodes contact same server and are both in same cell, then

  • switch info, and tell server about switch. nodes periodically make sure partner alive

• with unsynchronized clocks and freq switching, cannot easily reconstruct cycle
Landmark Databases

- Convert from location to known object
- how close is “nearby”
- Which databases of landmarks should be used
- Local override to database?
Indoor Tracking
Proximity Events
Room Level Tracking
Beacons & Listeners

• Room-level tracking requires beacons & listeners

• Two choices:
  • Scatter listeners throughout environment that detect your position & update server
  • Server provides location info & alerts
  • Scatter beacons throughout environment and your handheld is listener
Tradeoffs

• Handheld is beacon
  • better power usage
  • better precision (precise listener location)
• less interference
• Handheld is listener
• Control over privacy
• (Can you suggest others)
Bluetooth Beacons

• Bluetooth devices respond to inquires
  • with BT-ID and Name
• range: 10 meters (room level)
• leakage through walls & floors
  • hear floor 7, 8, and 9 --> you are on 8
• Inexpensive ($20 / beacon)
• Handhelds have BT
Bluetooth Beacons

• First decision -- Where to put beacons
  • Put them in PC’s -- they are everywhere
  • Unfortunately, they disappear :( 
• Put them in powered usb hub, near AC outlet
  • Initialize via laptop, then remove laptop
  • BT Dongle will continue to respond to inquiry
When detect BT dongle
update map location
What doesn’t work

• Signal strength does not work well
  • need radio map

• Track while walking
  • 10 sec to detect, walking rate ~ 1 m/s, easy to miss dongle altogether

• Embed location info in dongle name
  • takes even longer to detect

• Cached BT names, must not use
Several Hacks needed

- Takes too long to recognize dongles
- Faster if use two dongles
- Signal come and goes
- Incorporate model of human motion
- Probabilistic filtering

Image removed due to copyright considerations.
More hacks

- If you know where you are,
- then know where you might go next
- can do inquiry of specific dongles