Internet Geolocation and Location-Based Applications

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Agenda

• A general framework for geolocation and location-based applications
• State of the art and current trends
• Generalizing to the Internet of Things
Application Goals

So you want to build an application that does something with geolocation…

1. Where do you get location information for Internet devices?

2. How do you manage the privacy of users’ location information?
Actors

Location
Server

Application

User
Device
Applications

- Applications need to find a source of location information
  - User device or some external source
- Get location access, privacy protection through APIs
Location APIs

• Platform APIs:
  – Web: `navigator.geolocation.getCurrentPosition()`
  – Android: `LocationManager.requestLocationUpdates()`
  – iOS: `[CLLocationManager startUpdatingLocation]`
  – Likewise on BlackBerry, Windows Phone 7, Symbian, etc.

• HTTP APIs:
  – Standard: OMA MLP, ETSI Parlay/X
  – Vendor: LocationLabs, LOC-AID, et al.
Classes of applications

• Commercial applications
  – Mapping, weather, points of interest, etc.

• Regulated applications
  – Emergency calling (911) is perhaps the oldest location-based network service
  – Work is being done to extend to the Internet
    • IETF ECRIT working group
    • NENA i3 architecture
Location Servers

• Needs to be able to answer requests for location for some set of devices
• Needs a way to determine where an Internet device is located
• Many different ways to do this…
Positioning Methods

• Use registered information
  – Mining databases like WHOIS

• Use wired connectivity:
  – Wire maps (if done by Network operator)
  – Network mapping with ping/traceroute/BGP

• Use wireless connectivity:
  – Emitter observations (need a database)
  – U-TDOA, Cell-ID, Fingerprinting, etc.

• Use special hardware:
  – GPS and A-GPS
  – Inertial navigation with accelerometers
Who provides location?

• Device, using special hardware
• Third party, using collected information
  – Observations: Wireless signals, ping/traceroute
  – Direct/purchased access to information about infrastructure
• Network operator, using network
  – Desired case for emergency services / 911
  – IETF GEOPRIV working group
User Devices

• Brokers between location sources and applications
• Critical role in protecting privacy
• Which applications get access to geolocation?

Location Server Discovery

• Device has to choose which location server to ask
• Not all servers are created equal
  – GPS direct measurements
  – “World in a database” / observed services
  – Carrier-provided services
• Might want to switch between these based on context
Service Patterns

**Legacy / Third-Party Request**

- Location Server
- Application
- User Device

**Device-Mediated**

- Location Server
- Application
- User Device
Legacy / Third-party Request

1. User requests service
2. Application looks up user geolocation
3. Application delivers service based on location

• Problems:
  – Privacy risk
  – Accuracy
  – Server discovery
Related searches for gas station:
Brands: Shell, Sunoco, BP, Valero, Chevron
Stores: Circle K, Sheetz, 7-11, Walmart, Target

Filling station - Wikipedia, the free encyclopedia
The term "gas station" is mostly used in the US and in Canada, where the fuel is known as "gasoline" or "gas" as in "gas pump". In some regions of Canada, ...
Terminology - Number of petrol stations ... - History of filling stations
en.wikipedia.org/wiki/Filling_station - Cached - Similar

Images for gas station - Report images

The Shell global homepage - Global
production. See how we will build the world's first floating liquefied natural gas facility ... Job search - Shell station locator and route planner ... Show stock quote for RDS.A
Jobs & Careers - Shell Station Locator - Investor Centre - Card services
www.shell.com/ - Cached - Similar
8411 Leesburg Pike, Vienna 2 reviews
Device-Mediated

1. User installs application
   - App install or web visit
2. App requests location
3. Device collects wireless measurements
4. Device sends location request with measurements to location server
5. Location delivered Server to Device to App
6. App uses location to deliver service
Example
Expanding to the IoT

• Assumption for most apps has been that the thing being located is the service endpoint
  – Target == Client

• Probably not the case for lots of applications IoT

• How do current models extend?
Triangle to Quadrilateral

Location
Server

Application

Target

User
Device

New!
Target

• Needs to enable the rest of the system to locate it
  – If it can position itself, register somewhere
  – Provide measurements that another entity can use to position it

• This actually sounds kind of familiar…
Location-Sharing Applications

• Several applications already facilitate location sharing
  – Social apps with explicit user consent
  – Asset / fleet tracking apps are more “embedded”

• Maybe the IoT quadrilateral is just two triangles?
Open Questions

• Dynamic resource discovery
  – Best location server for a given context
  – “Things” in a given geospatial region

• Authorization / authentication with limited user interface

• How to manage privacy in a more thoroughly-observed world
Summary

• There are lots of location-based applications out there now
• But there’s a lot of similarity in how these services are delivered
• Location-based applications in the “Internet of Things” might be able to benefit from current services