

A Location Framework for Urban Sensing Using PostGIS and Geoserver

Doris Lam, Vids Samanta, Jeff Burke, Nicolai Munk Petersen, Deborah Estrin
 CENS Urban Sensing – <http://wiki.urban.cens.ucla.edu>

Urban Sensing: A sensor network of cell phones and GPS devices in an urban environment

SensorBase.org

- A web application with backend MySQL database for users to easily upload, tag, share, search, and analyze data
 - Sensor data can include text, numbers, images, audio, video, with temporal and/or spatial components
 - Great for traditional data, but limited in dealing with location data

Campaignr

- Software on cellphone that uses sensors on the phone and/or a paired GPS device to gather data
 - uploads to *SensorBase.org* or other data sinks
- Campaigns
 - Personal, social, or urban context – ex. Personal diet or medical monitoring, social network tagging, pollution in the urban environment

Location Services and Visualization: Managing and viewing location data

Location Scrubbing

- Privacy Concerns**
 When sampling a user's location traces, the question of privacy will inevitably come up. When does a user's location traces become *personally identifying*, that is, others will be able to identify the user based on his location trace pattern? What if the user does not wish to disclose his whereabouts during certain times and periods?
- Enacting a privacy policy**
 A user should be able to set a *privacy policy* in regards to his location traces. Enacting this policy requires a spatially aware system, to lower location data resolution when appropriate. For example, lowering fine grained GPS data to zip code, city, or county level. Such operations requires the system to be able to obtain associated coarse grain equivalents for each data point.

Location Attestation

- Verification of location data**
 To improve data credibility, we need some way to *attest* to user reported location data. A possible scheme is to have the network infrastructure independently measure the location of clients, and then compare that information with user reported data, using range checks.

Visualization

- Plotting location data onto maps**
Maps are a natural choice for visualizing location data. In the case of GPS data, each GPS reading can appear as a point or dot on a map, tracing out a user's path. We will also want users to be able to visualize data using temporal and/or attribute queries

A Location Framework: PostgreSQL database with PostGIS extension and Geoserver

The Components

- Geoserver**
 - An open source server, OGC certified compliant for Web Feature Service, Web Map Service, Web Coverage Service (WFS, WMS, WCS)
 - Output formats include KML/KMZ for Google Earth, raster image formats, Shapefiles, PDF, GeoRSS, and more
 - Allows styling of output using Style Layer Descriptors (SLD) and filtering using OGC filters or Common Query Language (CQL)
- PostgreSQL database with PostGIS extension**
 - An open source object-relational database and its spatial extension
 - Most tested on by Geoserver
 - Follows OpenGIS's "Simple Features Specification for SQL"
 - Open Geospatial Consortium (OGC) certified compliant with "Types and Functions" profile
 - Supported geometries include Point, Polygon, LineString, Curve, Surface, and collections of these geometries or their multidimensional versions
 - Spatial functions include Disjoint, Intersect, Within, Contains, Distance, etc.

Google Earth and Google Maps Visualization

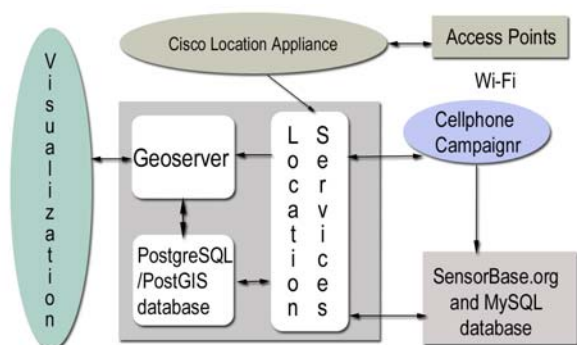


Left: location traces limited to one day (blue), or to zip code 90024 (red)
 Right: zoomed in – clicking on a point reveals its timestamp



Left: an example web interface for filtering and visualizing data on Google Maps (from PEIR Pilot campaign)
 • Choose users to display
 • Filter based on day, time, and/or zone attribute (see PEIR)

Overall System



Integration and Location Services

- Location scrubbing and attestation**
 Zip code, city and county boundaries dataset from U.S. Census Bureau can be used for location scrubbing. For attestation, we currently have a network of Cisco Wi-fi access points with a Cisco Wireless Location Appliance capable of locating wireless clients using signal strength triangulation and RF fingerprinting – taking into account surrounding buildings, signal attenuation, multi-path, and reflection. This second location measurement by the network infrastructure can then be compared to user reported location data using timestamps and range checks.
- A possible scenario**
 - User creates campaign on SensorBase.org
 - Campaignr uploads to SensorBase
 - SensorBase directs data to Geoserver box
 - location services – attestation and scrubbing based on privacy policy
 - spatial data gets stored in PostGIS, and possibly modified data are forwarded to SensorBase to be stored in MySQL database
 - User can visualize data through web interface, powered by Geoserver