CELL PHONE TRACKING

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Purpose

Cell phone tracking or positioning, which includes a tracking or location based service that discloses the actual coordinated a cell phone bearer, is a cell phone technology used by telecommunication companies and service providers to track or approximate where a mobile phone (and its user) resides. The more properly applied term tracking or locating refers to the purpose rather than a tracking or positioning process. Such a cell phone tracking service is offered as an option of the class of tracking or location-based service (LBS).

Therefore, Cell Phone tracking is the technology by which it’s possible to get traffic information using every switched-on mobile phone that becomes a traffic probe and is as such an (anonymous) source of information.

Description

Cell Phone tracking systems, are a specific kind of location-based mobile systems that are known under the acronym LBS (Location Based Services). In cell phone tracking the operator independently determines the user’s location without a specific request, consent or involvement from the same user.

The localization techniques are many and different from each other and are based on the measurement of one or more variables such as angles, time, distance or power signals. Using the estimate of the position in time of a radio mobile terminal it is then possible to rebuilding the speed and the trajectory followed by the terminal itself. This is called CFVD (Cellular Floating Vehicle Data): obviously the acquired data are not only related to vehicles but to the whole set of users of a mobile operator; on the other hand, considering the levels of penetration of mobile handsets, the available data can be "immediately" very high, especially in urban areas, and through advanced statistical techniques it is possible to obtain traffic information.

Relevance for Large Scale Events

The relevance for large events scale is still unknown, since cell phone tracking scheme is quite new compared to other method of traffic information acquisition.

Anyhow, Cell Phone Tracking could become an extremely relevant application for the management of traffic during large-scale events when the road network has to cope with exceptionally high levels of demand and there are likely to be a large number of vulnerable users, e.g. pedestrians, present in and around the sports/cultural venues, e.g. stadiums.
Options

There are different techniques and methods that are applicable and each of this needs for some hardware and/or software installed in the network of the mobile operator with a different technical and economic impact.

Technologies

The ability to position a mobile phone within a cellular network is well known. However, there are a number of challenges to be overcome including: collecting data without compromising individual users’ privacy, de-cluttering the millions of data points available into a usable data stream, and map-matching the resulting patterns to the road network, so as to measure flow or average speed and travel time or detect accidents. Advanced statistical techniques are requested to generate an economically viable source of traffic information.

The technology of locating is based on measuring power levels and antenna patterns and uses the concept that a powered mobile phone always communicates wirelessly with one of the closest base stations, so the knowledge of the location of the base station implies the cell phone is nearby.

Advanced systems determine the sector in which the mobile phone resides and roughly estimate also the distance to the base station. Further approximation can be done by interpolating signals between adjacent antenna towers. Qualified services may achieve a precision of down to 50 meters where mobile traffic and density of antenna towers (base stations) is sufficiently high. Rural and desolate areas may see miles between base stations and therefore determine locations with a lower precision.

Mobile phone localization is the use of multilateration to determine the location of mobile phones, or dedicated trackers, usually with the intent to locate the user.

Network-based techniques utilize the service provider’s network infrastructure to identify the location of the handset. The advantage of network-based techniques (from a mobile operator’s point of view) is that they can be implemented non-intrusively, without affecting the handsets.

The accuracy of network-based techniques varies, with cell identification as the least accurate and triangulation as moderately accurate, and newer "Forward Link" timing methods as the most accurate. The accuracy of network-based techniques is both dependent on the concentration of base station cells, with urban environments achieving the highest possible accuracy, and the implementation of the most current timing methods.

For example by combining the handover event and the cell tower intersection areas, it is possible to determine possible paths of a phone through a mobile phone network. Overlaying this information with a navigation quality digital roadmap, an analytical engine can determine the potential paths of vehicles through the road network. When this data is generated for many potential paths, patterns of road traffic information can be created. This information is then augmented with GPS probe vehicle data to assist in ongoing calibration of the system.
Care must be taken not to misinterpret cellular phones i.e. on a high speed railway track that runs parallel to the road as incredibly fast journeys along the road. However, the more congestion, the more cars, the more phones and thus more probes. In metropolitan areas where traffic data are most needed, the distance between antennas is lower and thus the accuracy increases.

**Impacts**

The potential impacts of Cell Phone tracking can be summarized in:

- **Advantages:** No infrastructure or hardware is needed to be built in cars or along the road. It is much less expensive, offers more coverage of more streets, it is faster to set up (no work zones) and needs less maintenance.

- **Disadvantages:** One of the key challenges of network-based techniques is the requirement to work closely with the service provider, as it entails the installation of hardware and software within the operator’s infrastructure.

**Integration potential**

The effectiveness of Cell Phone tracking services as part of the traffic management strategy could be increased when they are integrated with other ITS data acquisition technologies, for example conventional methods such as cameras or street embedded sensors or floating car data (FCD).

**Implementation**

It is not easy to sum up here practical indication for a successful deployment of Cell Phone tracking schemes, since they depend upon several city characteristics and other factors.

The implementation of Cell Phone tracking scheme should be integrated with other data acquisition systems like floating car data (FCD).
Examples
Case studies describing use of the tool:

a)  In previous large scale events,

During 1996 Summer Olympics in Atlanta TrafficSense application by Cellint was used to provide metro-
Atlanta drivers with real-time traffic data through Georgia NaviGAtor (www.georgia-navigator.com), the
DOT's traffic information Web site.

Georgia NaviGAtor is an Advanced Traffic Management System used in the U.S. state of Georgia. and was
first activated in April 1996, just before the 1996 Summer Olympics in Atlanta.

Most of the system was installed in metro Atlanta, where at least half of the state's population lives. It
includes traffic cameras, changeable message signs, ramp meters, and a traffic speed sensor system. Unlike
other ITS deployments around the world, Georgia Navigator almost exclusively uses video detection
cameras to gather traffic flow data, as opposed to traditional sensors embedded in the pavement. Additionally, a portion of the system (Georgia 400 and parts of I-16, I-75 and I-85 outside of Atlanta) receives traffic flow information from floating car data gathered by anonymously tracking cell phones.

Outside of Atlanta, Georgia Navigator components were installed on Interstate 475 near Macon during its
expansion from four lanes to six lanes. The Macon system is connected to the Atlanta TMC via fiber,[3]
allowing communication between the two centers. Georgia Navigator also has weather stations with
pavement sensors mainly in the mountain and coastal areas of Georgia. Traffic sensors are installed on
official evacuation routes, but are only activated during a hurricane approaching the Georgia coast or
eastern Florida panhandle.

Information from the system is distributed to the public through a variety of outlets. GDOT administers two
of its own websites (a standard version and a customizable "My Navigator" version), and operates a 511
telephone information service.[4] Additionally, Navigator data is used by several other companies, who
typically enhance and package the data for sale to various media outlets or private websites. An example of
a third-party use of Navigator data is The Weather Channel, which shows current traffic conditions
(provided by Traffic Pulse) during the local forecast portion of its broadcast.

b)  in more general contexts

Good practice examples (general examples, not only from large events)

Real Time Rome is the MIT SENSEable City Lab’s contribution to the 2006 Venice Biennale. The project
aggregated data from cell phones (obtained using Telecom Italia’s Lochness platform), buses and taxis in
Rome to better understand urban dynamics in real time
Number of cellular phone users in north-eastern Rome at different hours of a day. May 2006

Project for SRA in Skåne Region (Southern Sweden)

Cellint has been providing real-time road traffic information for the Swedish Road Administration since July 2007 through Info24, its Swedish integration partner, (www.info24.se). This project was initiated after a comprehensive bidding procedure where Cellint’s TrafficSense system was chosen by the Swedish Road Administration (www.vv.se) to deliver road traffic data in the region of Skåne, both on highways and arterials, including city streets in Malmö and Lund. Cellint’s technical score was the highest among all bidders. Cellint’s real-time traffic data was first delivered on July 1st 2007; only 3 weeks after Cellint signed the contract for this project.
Following the successful delivery, the Swedish Road Administration had decided to extend the term of this project and to expand significantly Cellint’s scope by 60%, to most of the main roadways in that area. This significant expansion covers both rural and urban roadways, city streets and intersections.
Sorin Sima, P&D Manager ITS of the Swedish Road Administration in Skåne Region said: “We are glad to have an opportunity to receive Cellint’s real-time traffic data over a much larger metro area and we expect to expand Cellint’s scope over additional roads by the end of this year. This expansion and extension of the project will enable the Swedish Road Administration to improve its service to the commuters and to maintain an efficient road transport system”.

Project for KDOT in Kansas City

On February 2006, a contract for testing TrafficSense was signed between Kansas DOT and Cellint to compare road traffic data calculated from cellular network data by the TrafficSense system to the existing road sensors data of the SCOUT system in KC (www.kcscout.com). The system was deployed within eight weeks, and after few more weeks of calibration became operational.
Changes in speed of the selected roadways were measured on data for 44 days (6/18/06 to 7/31/06) and compared to the road sensors, with special emphasis given to slowdowns of traffic.

Slowdowns are defined as a decrease of speed by at least 10 MPH during less than 10 minutes, where the speed before the slowdown is higher than 50 MPH and the speed during the following 10 minutes drops below 50 MPH.

Summary:

The table in the next page summarizes the comparison analysis between TrafficSense and the inductive loops at the SCOUT traffic control system at Kansas City. The analysis was performed on "blind test" data: Cellint supplied KDOT/KCScout with data during June and July 2006 and received the comparable sensor data only in August 2006. 36 files of raw data are attached to this report, together with comparison graphs such as the samples below (Magenta for road sensors, Blue for TrafficSense). The analysis shows that the average latency of detecting slowdowns by TrafficSense in comparison to road sensors at the location of the sensors is about 4 minutes, and the average difference between the systems in measuring the local speed over the sensors is less than 5 miles per hour.

Taking into account few other factors, as detailed in the comments below, will show that the real latency at the sensors' location is shorter.

Graph Samples:

Findings:

The analysis shows that:

There is a very high correlation between the cellular data generated by Traffic Sense system and those of the existing loop road detectors:

The average latency of detecting slowdowns by TrafficSense in comparison to road sensors at sensors' location is about 4 minutes*
The average difference between the systems in measuring the local speed over the sensors is less than 5 miles per hour.

The overall number of false alarms of the sensors was significantly higher than TrafficSense's.

System uptime was more than 99%.

* KDoT/SCOUT may use different criteria for slowdowns, so their final results may be different.

**Observations:**

TrafficSense proved to be a reliable and accurate traffic data collection system in real time.

This is the first cellular based traffic data collection system in the US to be successful at a controlled pilot, with results that were verified by an independent examiner.

Deployment and calibration of TrafficSense are much faster than traditional road sensors and don’t require dangerous road work at construction zones which contribute to traffic delays.

TrafficSense's cost benefit ratio suggests a much better return on investment for traffic agencies and road operators.