MI: An Information Support System for Decision Makers

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Abstract. Decision makers are key personnel working most of the time on critical duties. Information is the key to their success, and having the correct and up-to-date information is not an easy task; teamwork, where multiple parties have to work together is required. Though information is available everywhere in every action one may do during his/her daily life it has not yet been harvested as it should. Information in our approach is collected using a mobile device. Mobile devices are 90% of the time idle sitting in the pocket of its holder waiting for a call to take place or an SMS to be received. This 90% of the time is where this work focuses: monitoring GSM, Wi-Fi, GPS data and building a data warehouse. The data warehouse is the main source of information for decision makers, to succeed better in their daily tasks.

1 Introduction

Sources of information are multi-disciplinary; some information can be processed from the web, blogs, Facebook, Twitter, etc. Other types can be processed from data entry forms, whether simple opinion or a claim at a local restaurant to calling emergency numbers and placing complains. Surveillance data can also be processed for information retrieval. Surveillance data extends from local street cameras to surveillance camera in malls, individuals being watched, detectives, or even private eyes. Voice data can be captured and processed from people talking on the streets, to enterprise phone calls, to wiretapping and communication interference. With all this information, most people would agree that ignorance is bliss.

"Intelligence is the process of supporting the policy makers in making their decisions by providing them with the specific information they need" [1]. Information is the key feature of any law enforcement institution. Therefore, the more information is acquired and the more data is analyzed, the better decisions are taken and the safer are the streets and cities. Mobile devices are the source of information in this work. Mobile devices can provide different types of information, beginning with call log/SMS log to call recording, PDA activity monitoring, GSM

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network information, GPS satellite status, data communication over 2G network, 3G network, Bluetooth and Wi-Fi.

The rest of the paper is organized as follows: Section 2 provides related work. Section 3 provides the methodology of the work. Section 4 discusses mobile intelligence (MI) along with the technical details and database designs. Section 5 provides a real life scenario. And section 6 concludes the paper.

2 Related Work

In [2], the authors discuss the latest technology trends related to mobile internet - how mobile phones are becoming an everyday need. In 2008, 3.3 billion people- half of the world population - use mobile phones according to the international telecommunication union. They rely on 3G services such as:

- Mobile internet access for everyone with a mobile and a data plan.
- Mobile intranet and extranet access for enterprise users on the go, individuals who need to access office documents while at the client or outside the office.
- Customized infotainment.
- Multimedia messaging service between users, where large content of data over 3G network are sent.
- Location based services; services provided knowing the entourage of the user, like movie ad messaging of a theater nearby or resstaurant.

In [3], the authors present a tracking application integrated into a car targeted for car theft, teenage driving monitoring/speeding and vehicle tracking. The application can read the status of the car (parked, driven, locked) as well as more advanced sensor data if made available, also it can read the car alarm status if connected to the car alarm. The request for data is done in two ways: on demand and trigger based. The on-demand is controlled by a GSM phone that requests car status from the in-car system.

The authors of [4] introduce the GPS and GSM technology to the public transportation buses in the Punjab and Delhi cities of India. The system is made up of GSM modules to communicate, GPS devices to track, laser detectors to record passenger activities (going up on a bus or down) and a set of microcontrollers to establish communication between all sides. The approach is the integration of common new technology to simple aspects of the human life, the close monitoring and scheduling of public buses through the establishment of an operations room that track and audit the activity of public transportation.

The concentration of the authors of [5] is cellular tracking accuracy - how accurate can the output be by using the base cell location and signal strength.

The authors of [6] offer a roadmap from GERAN to 3G networks. The upgrade from GERAN to 3G passes from multiple phases starting from the core component all the way to the cells. The GSM will have to interface with UMTS, thus the protocols change. The way to go as proposed is either GERAN Iu or A/Gb. The first is a circuit switched network; thus, already taking the first step into 3G, since the GERAN Iu will traverse a 3G core network. The GERAN Iu upgrades to

UTRAN which makes the GERAN as if a fresh copy of the UTRAN 3G. Thus, the GERAN A/Gb was suggested and compared to the Iu. Both approaches have cost related considerations to be taken, it actually boils down to the operator to make the decision and see what is the more suitable in light of many considerations: cost, market, future services, etc.

The authors of [7] discuss location based services that are starting to emerge. Their proposed architecture for these services includes: target, position originator, location provider, service provider, content provider, and LBS user.

3 Proposed Methodology

Information is not only what one may find on the Internet, in printed media, or in visualized media. Information is born on sight or in thought or in action but rarely captured. "Rarely captured" because the amount of data generated compared to the amount of data collected is beyond comparison. Everything is information: daily actions (morning wake up, shower, breakfast) talks and conversations, as well as thoughts, ideas, dreams, situations. Any actions experienced by one of the human five senses can be considered as information; the human being itself is a giant data collector, data repository and data analyzer. The collection of data as per [1] can be classified in four categories: 1) the human based intelligence collection of data through trained personnel, 2) the imagery intelligence, 3) the open sources intelligence - these are publicly available, low-cost information sources, and 4) the signals intelligence.

3.1 GPS (Global Position System)

GPS system is the offspring of two military technologies: the American Navy's "TIMATION" program and the Air Force "Program 621B" [8]. Initially known as NAVSTAR GPS, the program took the best elements of TIMATION, used by the Navy for ships and submarine guidance and the Program 621B, used by the Air Force with four satellites constellation but unfortunately each served independently by ground-control stations. The NAVSTAR GPS was needed to replace the need of ground control stations as well as the TIMATION inability to provide position updates. The NAVSTAR consists of 24 satellites orbiting around the world providing all three locations axis, latitude, longitude and altitude. Initially designed for military use, this system has become more and more familiar in the domestic world.

3.2 GSM (Global System for Mobile Communications)

GSM is part of the 2G family of mobile communications. Mobile communications are the number one source of mobility. Users can call, SMS, access the Internet, anywhere, anytime as long as mobile coverage allows it. The main GSM network is made up of a cell (close to a bee-hive) structured network [9]. Mobile devices are connected to the GSM network using one main cell and six neighboring support cells. As the mobile user changes his/her location the main cell changes

and the cell with the highest power becomes the main cell and the six others are ordered based on power strength. The GSM network has evolved from GPRS to the 2.5G with the presence of EDGE. The data rates have jumped from 2 to 4KBps to 32KBps (kilobytes per second) [10]. In mobile communication voice has always been priority over data. The ratio at the base station is 70/30. 70 for voice and 30 for data. Given the nature of the data packet switching, this ratio is increased for the benefit of voice. Thus, making it 80/20 even 90/10. This is about to change with the evolution of the mobile network. Voice is becoming cheap and data plans are being the main decision taking feature when users are to choose a mobile plan. UMTS, Universal Mobile Telecommunication Systems, is nowadays the new mobile standard or what is known as 3G [11]. The 3G network was created to support superfast connections compared to the current mobile network, from 236Kbps to 2Mbps and with HSUPA 7.2Mbps.

3.3 Wi-Fi

The wireless networks have grown large in the past decade, due to two simple facts: wire-less and mobile. More mobile devices are having the feature of Wi-Fi nowadays, especially in countries where 3G data plans are not available - actually where a3G network is not found [12].

3.4 GPS/GSM/Wi-Fi + Information

Wi-Fi cannot be localized given the huge number of wireless networks being created and removed every day. Wi-Fi unlike GSM does not require any legal papers to setup a Wi-Fi Internet in a certain area. For example a Wi-Fi hotspot W cannot be shown on a map because it is not registered while a cell id Y can be easily pointed out on a map. The GPS information is there to geotag. GSM network coverage is nationwide but the cells and power differ. What better way than geotagging the GSM cell and power at each GPS movement of a person on the move! Cell information is per serving cell, meaning the six neighboring cells information is not recorded. The Wi-Fi hotspots on the other side are as many as there can be; thus, Wi-Fi geo-tagging will geotag many Wi-Fi hotspots at a certain location latitude and longitude.

GPS coordinates, GSM cell id and power, Wi-Fi MAC address, name and power are three types of information that one walks through but never grabs. The MI project is a Wi-Fi, GSM, GPS information collector, Wi-Fi geo-tagger GSM information for future analysis.

4 Why MI?

The main motive behind the idea was to extract as much as possible information from a mobile device. Our work is, accordingly, what can be extracted from a mobile device. This includes: contacts, short messages, call logging, call conversations, media (pictures, music, tones, and videos), web browsing information, and geo-locations.

Primarily the information consists of the surrounding and not the activity of the mobile user itself (i.e., geo-locations). Geo-locations targets three components of the mobile device: the GSM/UTMS module, the GPS antenna and the wireless LAN (our work considers a modern mobile device as one that has all three services). The GSM module, mainly used for GSM/UMTS communications and GPRS/EDGE/CDMA/HSDPA for browsing, holds information of the main GSM cell as well as the signal strength and six neighboring cells. This information is subject to change due to the number of devices and voice calls taking place around the device. Wi-Fi hotspots are the easy internet access portal, available in any home, at the corner of every major city, in malls and servicing stations. Wi-Fi spots do not need licensing to work - just plug and play. Thus, the Wi-Fi stations of a country cannot be swept or calculated using a backbone device like in the case of the GSM network where the cells are in precise locations and their area of service is preconfigured. Last but not least, the GPS module is there to geotag the GSM network information as well as the Wi-Fi network information, creating four data layers: static GSM cell locations layer, dynamic GSM cell power layer, static Wi-Fi hotspot locations layer, and dynamic Wi-Fi hotspot signal coverage.

The Wi-Fi layer, shown in figure 1, portrays all the locations where Wi-Fi data are collected. This data will be processed into 30 to 50 meter buffers; thus, making it easier to visualize and query. Besides the above layers, the GSM and Wi-Fi information collected from the mobile device will be used as raw data, for information support system used by decision/policy makers.

Fig. 1 The Wi-Fi layer.

MI collects upon movement the GSM cell data as well as all Wi-Fi hotspots in view. The data collected is appended to GPS coordinates and stored on the device. The device then synchronizes with the back office where the main data-warehouse is used for pre-processing and quick analysis. MI provides an intelligence database for decision makers. Consider a database with rich data about Wi-Fi hotspots, their MAC address, and their signal strength, about GSM cell ids and

their signal, about GPS information speed, heading, and accuracy, all this data linked to a coordinate system, everything is there on a map to see and decide.

4.1 Technical MI

MI is a mobile application built using Windows Mobile 6 and Visual Studio 2008. The primary language of choice is VB.Net, and then we switched to C# since parts of the code required a wrapper for C++ libraries. The GPS library used is the default Windows Mobile Positioning Sample. The Wi-Fi and the GSM are C++ wrappers. Microsoft SQL Server is the main data collector. For the back office, the Enterprise 2008 Edition is used, and on the mobile devices the Compact Edition 3.5 Service pack 1 is used. The GIS data viewer is the ESRI. ArcGIS desktop 9.3.1 is used to display the data. The GIS data tests were done at a local GIS company.

4.2 Database Design

The database structure is made up of one main table (GCW) and three supporting tables (GPS, GSM, and Wi-Fi). GCW carries GPS data, cell information and Wi-Fi. The rest of the tables are supporting tables, holding additional information for the GCW record. The GCW and GPS records share only latitude and longitude, while the GPS table holds the speed, heading, altitude, GMT time, etc. The GCW and GSM have in common the Cellular ID and the Cellular ID power, and GSM holds the country code, the name base station information, etc. The GCW and Wi-Fi have in common the main Wi-Fi hotspot Mac address and power, the rest of the Wi-Fi in view are recorded inside the Wi-Fi table.

The GPS table holds all detailed GPS information. This information is the global positions on a 2D map, the longitude and the latitude in decimal degrees for accuracy, the altitude with respect to the sea level, along with the levels of precisions of this information. The speed and heading are also present, as well as the GMT date/time value.

5 An Example

The main use of MI is best expressed in the law enforcement or military field. The normal scenario in an operations room is to track outlaws. Consider the case where the outlaw is traceable using his mobile device and the outlaw is on the run. Given the sensitivity of the information, only law enforcement agencies can have access to a mobile device subscriber's current cell tower ID and power. Also, the information of cell towers and their area of service by power can only be provided for law enforcement companies. Now the information provided by the telecommunications company shows the locations of the cell towers, and the range of signal strength. The area covered is large; thus, making the decision hard. This is where the MI data comes in handy. The data will be drawn as intelligence over the maps layer. The tentative location of the fugitive will be highlighted given the amount of data and the accuracy with respect to time. The question to be asked is:

what data does intelligence provide for this cell information and power at the current time? Thus, the decision maker has more options to look into before taking his/her decision.

Another scenario is where a local hacker is doing an intrusion into a governmental site. Given the technology at hand in law enforcement companies as well as the military, one can know the set of routers the communication is being made through. Thus, at any moment the decision maker can compare this information to the data collected using MI and get the possible location of one of the routers.

As an example, the MI project for a certain city starts with data collection. The data is collected using handheld devices by agents patrolling the different areas of the city at different times of the day. While on the move, MI will record all the necessary GSM, GPS, Wi-Fi information and save it inside a local database on the PDA, using Microsoft SQL Compact Edition 3.5 SP1. When a certain agent returns to the field, the data is synched between the handheld device and the back office data warehouse using Microsoft SQL Server Enterprise 2008 web synchronization service. This latter can also be publicly available for sync on demand while agents are in the field. Once the data is made available, MI can start serving decision makers. In a mission that requires tracking a fugitive via his/her mobile phone, the decision makers will need to acquire up-to-date mobile phone information from the local mobile company operations room. The information received from the mobile company includes the current cell id and signal strength of the fugitive. Accordingly, the decision maker will see the main cell id location on the map and the area where the corresponding signal strength as shown in figure 2. This information is based on what the mobile company has provided as maps and signal strength area when the mobile company was established.

In figure 2 the cell id 1 and signal 40 is reflected by the -040 value next to the cell id tower, while cell id 2's signal strength is reflected by -060 and cell id

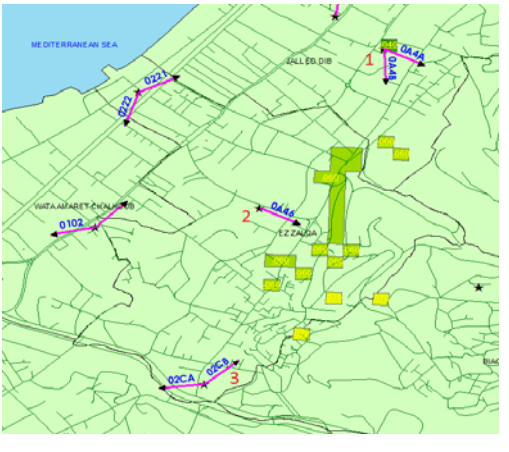

Fig. 2 Fugitive pursuit with GSM provider data.

3 by -070. The fugitive is talking from cell id 1 with signal strength -40. The information provided from the GSM network provider is poor and often old, not allowing the decision maker to implement a quick strategy to intercept the fugitive. Now the fugitive is on the move and has passed to cell id 2 (in figure 2, noted in red next to cell id). The area coverage is bigger but still no accurate data. The fugitive moves now to cell id 3 with and again the signal strength area is poor. The introduction of MI to the equation will give a scenario similar to figure 3.

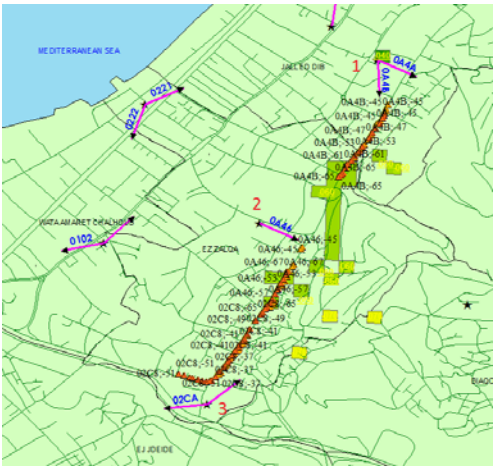

Fig. 3 Fugitive pursuit with GSM provider data and MI data.

MI has provided with the information found in hand the different location where a possible cell id 1 and power -40 can be, as well as cell id 2 and power -60 and cell id 3 and power -70. With this information in hand the decision maker can better target an interception strategy.

6 Conclusion

MI covers some of the major mobile device technologies such as Wi-Fi and GPS. MI extracts as much information as possible from a mobile device to help in the decision making process. As a future work, the GSM neighboring cells will be covered to get the most information from a location in a GSM network. Working with accelerometers is a new challenge that we are currently undertaking. MI was introduced as a decision maker's tool, but MI is multi-disciplinary - the information can be used by mobile companies to offer better services and plans.

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