



## Privacy in Location based Systems

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**Abstract-** Recent advancements in technology have opened new avenues for services like the Location based services. Location based services are applications of mobile technology that utilize the information about the location of the user. It uses the Global Positioning System GPS to acquire and transmit user location. Billions of people create an unprecedented amount of data that either includes or allows the inference of highly sensitive information amidst which user location is one of them. However, this information is shared with third party without the knowledge or consent of the user. This is a violation of privacy as some users will or may not want to disclose their location to some people. This paper aims to raise awareness about privacy issues created as a result of location based services. History of location based services were discussed, information privacy and privacy issue surrounding the location based service were also discussed. Despite the myriad opportunities location based services provides, it is required to ensure security of user's private data, and data protection laws be put in place to enforce this.

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## 1. INTRODUCTION

The Internet has fundamentally changed our society, the way we live, work and express ourselves. Improvements in information processing and communication technology have created mobile devices that allow the usage of smart mobile services, such as applications, that keep us constantly connected and that deliver digital content. Millions of such mobile service are available today. While being inexpensive in terms of actual money, user data has become the actual currency, rewarding the company that knows the most about their users. This has created an eco-system, which invisible during normal usage, records virtually every action online. The recorded data fuels sophisticated artificial intelligence algorithms that learn our interests, desires and secrets for purposes such as behavioural advertisement and surveillance (Chow & Mokbel, 2016).

At the beginning of the 21st century the Internet fundamentally changed. Instead of simply consuming content, users started to create the content themselves and to use interactive and collaborative services. This development, commonly referred to as Web 2.0, has significantly influenced our society. People spend a substantial amount of their time in online social networks communicating, socializing, engaging in their hobbies or

expressing their opinions (Michael, 2016). Events all around the globe are almost instantly reported via instant messengers and hundreds of thousands collaboratively create and maintain large online encyclopaedias.

During the last decade, mobile devices, such as smartphones and tablet computers, have further increased the ubiquity of online services. Engagement in online communications or purchase of items online are done at home, on a desktop computer, at any instance of time. Furthermore, sensors of mobile devices, such as Global Positioning System (GPS) sensors are employed. This does not only allow engagement in context aware services, but also increases the types of information that can be created, transmitted and stored at remote machines.

A consequence of these developments is that billions of people create an unprecedented amount of data that either includes or allows the inference of highly sensitive information. Either way, it turns out that the entity that learns such information can use it in an extremely profitable way. The services that know more information about people are able to optimize their services and thus attract more users. Furthermore, services that know more about the interests of their users are able to present them behavioural advertisement (Scassa & Sattler, 2013). In this particular form of online advertisement, online advertisers present targeted adverts that relates to the user's online activities. In a simple example, a user who was recently shopping online for cloths would receive matching advertisement where other users would see different advertisement. Today, a multi-billion dollar economy exists whose main driving factor is user data. Users are typically unaware of the exact functioning of this industry. They are not aware of, for example, the multiple trackers that they download when visiting webpages or the Advert and Analytics (AA) software that they run on their mobile devices. They are also not aware of how their data is collected, aggregated and processed in economic transactions (Hoofnagle, King, Li, & Turow, 2010). These data collected based on user's location are used to provide services for users hence the name, location based services.

This research is tailored towards addressing the ethical issues as regards the privacy of users when using online mobile services. Section 2 discusses Information privacy, the historical background of Location based services was discussed in section 3, positive use of location based services as well as

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location based services and privacy issues were discussed in sections 4 and 5 respectively. The final section concludes the paper.

## II. INFORMATION PRIVACY

There are many definitions and aspects of privacy but information privacy has received considerable attention during the last decades (Chow & Mokbel, 2016). Matthew 7:1-12 gives account of the Transfiguration. Jesus had to select few people (Peter, James and John) he wanted to share information with. In verse 9, he strictly instructed them not to share the information with any other person. This is a typical depiction of information privacy. Information privacy is the study of the field between the massive data dissemination/collection/processing and the legal/political/technological issues surrounding them. It has significant impact on the way people live in the information age (Hartin, 2012). The question of how we shape our society in the information age is extremely challenging (Solove, 2002). One of the first discourses on information privacy is Warren's and Brandeis's work on The Right to Privacy (Chow & Mokbel, 2016; Warren & Brandeis, 1890). Concerning the technology that allows instant photographs and its meaning to the privacy of society, the question how the law is supposed to protect the peoples' privacy was raised (Warren & Brandeis, 1890). It was argued that people have the right to be left alone, i.e. the freedom from interference. There are, however, other scholars that have a different school of thought from Warren & Brandeis's view. They defined privacy as the right of individuals, groups, or institutions to determine when, how, and what degree of information about them is to be communicated with others (Boguslaw & Westin, 1968).

While the described technological advancements have brought society numerous advantages, their threats to information privacy cannot be doubted. Nowadays, billions of people constantly create data while they browse the web, use online social networks or employ their mobile devices. The latter are typically equipped with several sensors allowing to process not only virtual activities, such as clicks in apps, but also to process physical location, audio, video and so on (Anuar & Gretzel, 2011). It is easy to see that processing such data is a very delicate matter as it allows to gain very sensitive insights in the private lives of the users. With an estimated 50 billion devices on the Internet in 2020, the world is becoming a global environment in which virtually every electronic device is able to communicate to any other device.

People need to reveal some basic information such as residential address, bank account information, tell friends about weekend plans and many more. Information privacy is therefore a relational concept that depends on the entities involved, such as close friends,

family, employers, service providers and government agencies. There is a broad consensus that privacy is valuable and beneficial at an individual, group, organizational and societal level, where the individual and the societal level have received most attention. It is essential for an individual to decide which information about herself in which situations should be revealed.

Intimacy is constituted and signalled by the information that people choose to share with another. People create different levels of intimacy and trust depending on the personal information they disclose. People create intimacy on the basis of what experiences they share with each other. However, this would not be possible without privacy. People need personal space, and thus privacy, in order to separate themselves from others. Removing that space leads to hostility and unease. Two values of information privacy were enumerated (Chow & Mokbel, 2016). First, preventing misuse of personal information since the individuals are able to control their own information. Second, avoiding embarrassment for actions that are perfectly normal, yet, when exposed to the public, are considered to be embarrassing.

## III. HISTORY OF LOCATION BASED SYSTEM

Location based services were first introduced with Enhanced 911 (E-911), an initiative of the US Federal Communications Commission (FCC) to make all wireless phones location capable. The goal was to enable emergency services to quickly and accurately determine the location of a call placed using a cell phone and to deliver the location information to the closest Public Safety Answering Point (Federal Communications Commission (FCC), 1999). Operators of mobile services began to introduce commercial location based services in order to gain return for their E-911 investments. These initial developments were characterized by finder services, where information was sent to a user upon request (e.g. finding a restaurant or a tourist attraction). As a result of poor design, limited precision and reduced functionality, these services failed to gain popularity.

Significant changes in location-based service technologies were made possible by the development of low powered GPS-enabled mobile phones and assisted GPS, as well as the introduction of the 3G broadband wireless services. Better location based services, such as real-time mapping, points-of-interest content or navigation support, could be offered with the advent of new GPS-enabled mobile phones and devices, which support high accuracy positioning. These improvements led to the next generation of location-based services, which facilitated the delivery of mundane services at the push of a button (i.e. calling a taxi to the user's location without dialling a service

operator), or allowed a user's location to trigger the sending of information to the mobile device.

One of the reasons why location-based services have gained in popularity is the shift from a reactive to a proactive system. While a reactive system simply responds to a user's location, a proactive system allows users to register their interests and/or preferences. Based on this information, the proactive system will automatically push relevant content to the user. In a location-based system, this might include notifying users when they are approaching points of interest. These proactive systems require less input from the user, yet deliver a wide range of information. These systems require a constant tracking of the mobile device to enable an efficient supply of information.

Another recent development is the emergence of cross-referencing services, where the user and the target for information are not always the same. This service takes information from one user in order to serve another. For example, in May 2011, it was reported that TomTom, a manufacturer of portable satellite navigation systems, was selling anonymized data collected from its high-end navigation devices to authorities throughout Europe, U.S. and Canada, to be used for traffic control purposes (Scassa & Sattler, 2013).

The multifunctional nature of GPS equipped smart phones adds to the complexity of location information capable of being shared. This includes cell phone camera functions that geo-tag photographs. Accelerometers, a type of sensor that is increasingly common in mobile devices, are capable of measuring acceleration, tilt and orientation, and thus have the potential to increase the fine detail of the location information that is being gathered. Transportation systems can also make use of and gather data from GPS-enabled mobile phones on board vehicles in order to estimate the traffic flow on roads and highways.

Location-based services continue to evolve as new technological capabilities become widely available and highly affordable. One example is the availability of location sensitive billing services, where certain service providers can automatically charge a user when using their service, such as road tolls.

Research is being conducted on applications with augmented reality features, which would enable a mobile phone equipped with a camera, a compass and a GPS to superimpose information about points of interest on a live camera view, based on the phone's current position, orientation and the direction in which the camera is pointing (Scassa & Sattler, 2013).

#### IV. POSITIVE USE OF LOCATION BASED SYSTEM

The potential for the development of location-based services is virtually limitless and may extend into

every sphere of human endeavour. An obvious benefit brought by location based services is the ability to filter vast amounts of content available over the Internet, and to deliver to the user only information in which may be of interest. For example, a simple query for a pharmacy would not return all registered pharmacies for the user to sift through until user finds the pharmacy closest to his/her location. The location-based service would return information related to only those pharmacies in the user's immediate vicinity. Location-based services also serve the user by pushing information such as discounts or coupons, alerts of risks when entering a high-crime district, or warnings before encountering a traffic jam on the highway. Furthermore, by sharing location information, all users benefit from more current localized information. Mobile devices connected to location-based services can also assist in finding missing persons (Scassa & Sattler, 2013).

Location awareness may also permit a variety of health and emergency management benefits. For example, the Virtual Blood Bank Project in Delhi, India uses smart phones to build a pervasive network capable of giving users instantaneous information about available blood donors in their vicinity, which may be critical in emergency situations. Other health care applications may include the ability to transmit critical health related information to a hospital along with the patient's location and estimated time of arrival to the emergency room, allowing the hospital to make all necessary preparations before the patient's arrival.

#### V. LOCATION BASED SERVICES AND PRIVACY ISSUES

Multiple trackers are used to identify user location as they visit the web and use other smart devices. Location based technologies are technologies capable of providing services personalized to the geographic location of a user based on a given handheld device for a particular purpose (Anuar & Gretzel, 2011). Location based services offer information about a user's whereabouts and personal location to entities other than the user. With the proliferation and widespread adoption of mobile telephony and data, service providers have been eager to exploit customer information they have acquired over time. User location has traditionally been difficult to pinpoint and use due to its inherent dynamism and unpredictability (Michael, 2016). The rise of new technologies integrated into lightweight mobile devices and terminals, pinpointing location already a reality.

Location-based services are proliferating largely due to the dramatic rise in the number of GPS-equipped mobile devices used by consumers. Such devices include smart phones, tablet computers and hand held Global Positioning Systems (GPS). Newer versions of



internet browsers are also “location aware”, facilitating the use of location information in tailoring the user’s web experience.

There is no doubt that many location-based services offer real benefits to users. Yet location-based services raise inevitable user privacy concerns. These concerns operate on multiple levels and involve many players (Scassa & Sattler, 2013).

Despite the enormous application potential introduced by LBS for enhancing safety, convenience, and utility in our daily lives as well as our vacations, LBS also raise myriads of privacy issues due to the ability to collect, store, use and disclose the locations of users (Wang & Loui, 2009). Some of the dimensions that assess individuals’ concerns for privacy are (1) the collection of personal information; (2) unauthorized secondary use of personal information; (3) improper access to personal information; and, (4) errors in storing of personal information. While privacy issues are a general concern for Internet services and mobile apps, people are especially wary of location information being abused (Michael, 2016).

LBS offer real-time navigation software, social networks that allow customers to check in as they go from place to place, local weather, geographically targeted search engine results, and other useful functions. The geolocation data is gathered in a number of ways-through global positioning system (GPS) technology built into devices, IP addresses, or Wi-Fi network mapping.

Proverbs 25:9 provides the following advice: “Argue your case with your neighbour directly, and do not disclose another’s secret” (Proverbs 25:9). This verse is explicit with regard to respecting another’s privacy. Not only is it understood in this verse that one is entitled to privacy, but the act of breaching another’s privacy is openly censured (Glass & Cahn, 2017). A 2010 survey conducted for Microsoft in the United Kingdom, Germany, Japan, the United States, and Canada found that 94 percent of customers who had used location-based services considered them valuable. However, the same survey found that 52 percent were concerned about the potential for loss of their privacy through the use of geolocation data (Roxin, Gaber, Wack, Nait, & Moh, 2012). Among the privacy concerns related to location-based services are; Notice: Customers want to receive adequate notice that an app will collect and use their geolocation data and give their consent for it to do so; Control: Customers want to have access to and be able to limit the collection and use of their data; Retention: Customers want to be informed about the policies that govern the retention of their data; Reuse: Customers want to choose how their data will be used and how it might be combined with other data; Disclosure to third parties: Customers want to control how their data is shared with third-party apps.

Location-based services may also result in the collection of a new layer of personal information about consumers by private sector companies. Information about individuals and their movements has meaningful commercial value, and the potential for the collection, use and disclosure of this information is significant.

## VI. CONCLUSION

The proliferation of location enabled mobile devices in the hands of consumers has led to a rapid development of location based services. The collection, use and disclosure of personal location information via these services raises serious privacy concerns, particularly given the sensitive nature of location information. A complaint-driven approach alone is not sufficient to ensure adequate protection of consumer privacy. There is need for data protection laws to further improve the legislative framework. As with many other services delivered through wireless communications, there are significant issues around how the informed consent requirements of data protection legislation can be effectively met. Appropriate norms for notice and consent to data collection in online and mobile environments would be of great importance. Although location-based services may offer attractive and beneficial opportunities to consumers, they do pose significant privacy risks. Because of the sensitive nature of location information, these risks may translate into significant material, moral and even physical harm. This is an area that calls for clear, proactive policy guidance and strong enforcement measures.

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