A Comprehensive Study of GPS Communication Security

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ABSTRACT

GPS Communication is of immense importance and has gained a significant amount of interest considering the research perspective. It reflects upon the location of individuals and is also respective of the security-based aspects. It is important to realize that the application of GPS is utilized in multiple domains including Big Data, AI, and Fleet Management Systems. This review article is a reflection of relevant literature where different things have been discussed in regard to the architectural and application perspective. The research aims at providing a better picture of the current trends in GPS technology and recent research.

Key words: GPS, Antenna, location, socialization, security, cyber-security, big data

1. INTRODUCTION

GPS is a system of global positioning that operates via satellite. There are three primary services of a GPS satellite[1]. These include navigation, timing, and positioning. "Global Positioning System" is a combined blend of 24 satellites. However, the usage of GPS in terms of applications and location accuracy is irrespective of any charges or subscriptions. Suppose the functionality of the GPS satellite is taken into consideration. In that case, it is essential to realize that these are a set of 24 satellites revolving at a distance of 12,000 miles from the ground. Constant revolutions take place on the part of these satellites, thereby making two complete revolutions each day[2]. The speed of the GPS satellites is 7000 mph, where solar energy is being utilized as the primary source. In case there is no solar energy, the batteries serve as a power source for the satellites. For ensuring a correct revolution by the satellite, rocket boosters are placed on every satellite.

In 1973, the GPS project was initiated to overcome the limitation of previously implemented systems[3]. The ideas and thought processes behind the design were a combined blend of the once generated ideas of other positioning satellites. At first, "The U.S. Department of Defense" established a system that utilized 24 satellites. The design at first resembled the radio navigation systems (ground-based) that include Decca Navigator and Loran implemented in the 1940s[4].

If the overall GPS positioning system is considered, these consist of 3 essential segments. The first segment reflects the space segment containing signals being transmitted alongside the satellites[5]. If the second segment is considered, it consists of ground facilities. This segment reflects on the processes like satellite tracking, computations for the orbits, and necessary supervision for keeping the first space segment under control. The last segment reflects upon the aspect of users enlightening the processes being carried out by them[6]. These include a series of applications and also have computation-based techniques.

Twenty-four satellites revolving in six orbits at the height of about 20,200 km from the Earth's surface are a part of the space segment[7]. These have an inclination angle of 55 degrees. The primary purpose is the assurance that 24 satellites are available. On the contrary, master control stations and the control uplink stations are a part of the control segment. The master control stations are located in Colorado, containing 3 control uplink stations[8]. The ranging information from the broadcasts is collected on their part. Lastly, if the computation of the exact location is taken into account, it is a part of the user segment. It consists of processors, receivers, and antennas for users on land, water, and air to compute the users' exact location.

This review is focused on unveiling the architectural evolutions with time. In addition to this, other aspects include the advancements in daily life reflecting upon the different application-based aspects. Lastly, the relevant literature shall also be considered, enlightening the productivity-based aspects.

2. SOCIAL INTERACTIONS BASED ON MOBILE APPLICATION

In many aspects, mobile applications have evolved with time. It is essential to realize the socialization that has aimed at an increase in social circles[9]. Many applications exist nowadays that contribute toward a better user experience. The core element of the system is the positioning system for the GPS. The three coordinates reflected from the system include altitude, longitude, and latitude[10]. However, many factors affect the position of a device/individual. These include environmental obstacles, weather information, and signals of the cellular device. Former advancements also enlighten the different types of views depending on the signals. Two types of interfaces are currently found in modern-day applications. Map views are ideal for poor

location accuracy, whereas list views are ideal in the case of location accuracy[11]. Four to five satellites are utilized for such location systems at a single time. The working mechanism for the system is based on the positioning technology being used in smartphones for the relevant location tracking. Lastly, an important aspect is the use of chipsets for the GPS sensor. Many types of chipsets are being manufactured. An example of Android and Apple smartphones holds immense importance. AG chipsets are being utilized by android smartphones, whereas Apple iPhones use chipsets by Broadcom Co.

The interaction protocols for a smartphone is shown in the figure below, where CPU, RAM, ROM, and Radio RX are the essential elements for the GPS module being utilized[12].
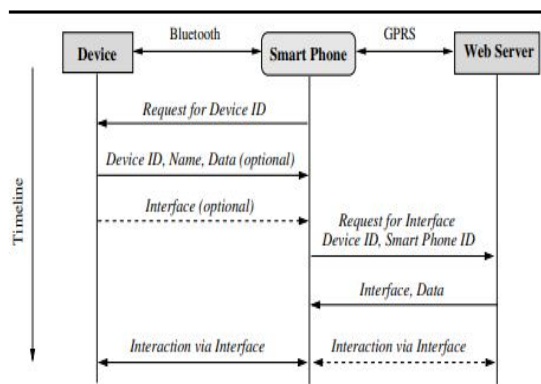

Figure 1: Interaction among the smart phone protocols [13]

The importance of a network, especially a "real-time network," needs to be considered because GPS working is based on that. It is irrespective of the human control, and location tracking is an important outcome of that.

3. VEHICLE TRACKING SYSTEM

An important application for the GPS is a vehicle tracking system used to monitor vehicle location at all times. If the daily life aspects are considered, it is important to realize that the theft rates have increased nowadays[14]. Such tracking systems play an important role in providing information about the actual geo-location. If the implementation on a prototype level is considered, then important aspects conclude the use of C-type programming alongside an LPC-2148 chipset. Both C-language and the LPC-2148 chipset are integrated to develop a vehicle tracking system.

The architecture enlightened in the figure below is a representation of how drivers can be traced while orders or goods are being transported to a particular driver.
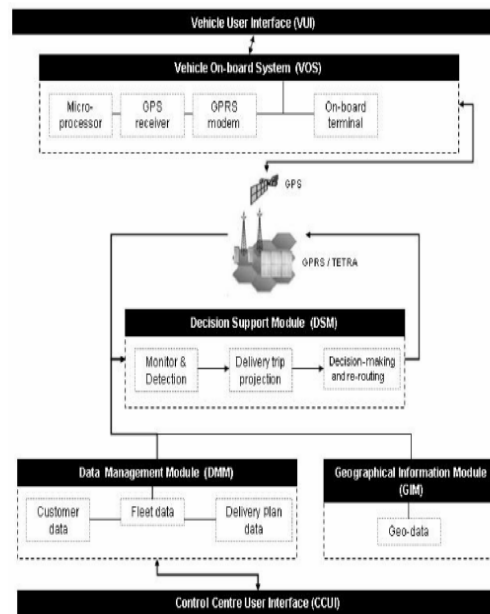

Figure 2: Routing architecture for Vehicle Tracing [15]

Two important modules are utilized for the system. These include a GSM (Global System for Mobile Communication) and GPS (Global Positioning System). The architecture enlightens the use of satellites through which the GPS radiations are transmitted to the receiver. The information is then sent to the server through GPRS, where a message is conveyed to the owner. In addition to these basic modules, the alcohol sensor enlightens the driver's condition, and the temperature sensor determines engine health.

4. ANALYSIS FOR SIERPINSKI METHODS

The Sierpinski methods were first proposed by Franciszek (1969), who had initially presented it as an initial triangle. The analysis is done such that the base is the crossover for square Patch[16]. The methods analyzed for the GPS applications are circular and square slots. Thus an 8 dB enhancement is an outcome of the circular slot Sierpinski method compared with square slot crossover, where such an enhancement doesn't occur. The design for the crossover was in the form of a streamline, s micro streamline[17]. The base was selected as a square patch. In the base, the polarization of the same feedlines occurred, whereas copolarization took place for the opposite ones. The implementation of the methods takes place such that the substrate is utilized as Rt Duroid[18]. The thickness and length are kept at 0.64 mm and 20 mm, whereas the dielectric constant is 10.2. If the overall Sierpinski method analysis is considered, then these provide a clear picture for applications of GPS where the positioning phenomenon is a result of the crossover of Sierpinski[19].
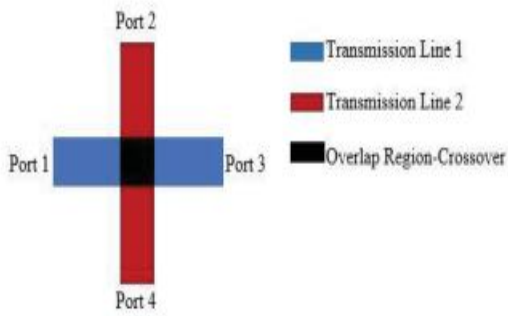
Figure 3: Four Port Crossover [20]

5. FLEET MANAGEMENT AND SECURITY

If the vehicle management system is taken into consideration, then these involve the administration processes for trucks, vans, etc. Major outcomes for the system include safety and risk minimization alongside a productive focus[21]. Alongside the transportation costs, the staff costs are reduced in multiple ways. There are two core elements of the system an in-vehicle and a server system. A Linux-based Cubie Truck board is used to implement the in-vehicle system. There is also a GPRS/GSM modem used to establish a connection between the two core elements of the system. The server system plays a key role in maintaining a database from the in-vehicle system[22]. The GPS module utilized in such a system for location tracking is a "GPS-634R." The module reflects details like time, date, and speed for the ground level. The baud rate at which the modem operates is 9600.

Figure 4: Protocols of Fleet Management[23]

6. SECURE WALKING GPS: DEPLOYMENT OF SENSORY NODES

The manual Deployment of sensory nodes has also gained immense importance in recent years, prioritizing the application of a Walking GPS. Implementing such a GPS is such that a periodic broadcast for location information occurs through the phenomenon. The inference for the position takes place through Sensory Nodes[24]. The developments in GPS research have led to a rapid change in trends with unprecedented innovation. Many innovations have contributed to major innovations, such that new algorithms have been developed[21]. The contributing cause in that regard has been increased localization. The structure emphasizes two types of different motes. One is a sensor mote, whereas the other is a GPS mote. The essential component for GPS mote is MICA 2 mote. The working for the deployment network is respective of the deployer where the GPS Mote gets attached to it. The assembly mote for the GPS can always get attached during the process. It is connected via a cable "RS232."
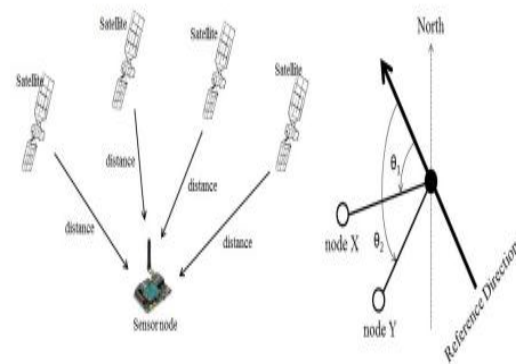

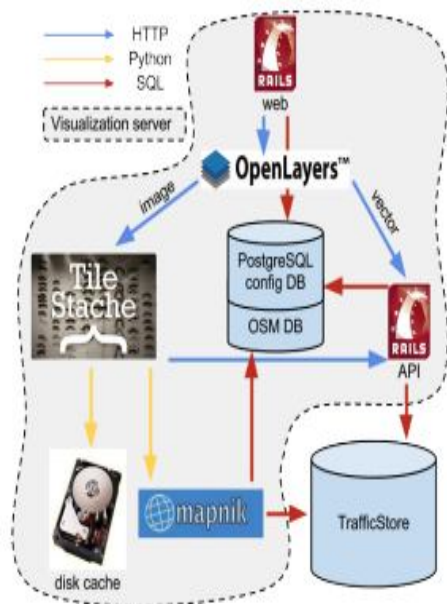**Figure 5:** Walking GPS:Sensory Nodes Deployment[25]

7. CHALLENGES IN CYBER SECURITY

Recent developments in cyber security have resulted from artificial intelligence developments alongside machine learning. Machine learning has also played a significant role in identifying suspicious activities alongside the behaviors[26]. The fraud within and outside of the organizations has started to increase with time, which has given rise to such problems. The problems regarding the GPS need to be addressed because it has been a growing concern over the years. Fraudulent activities like spoofing need to be addressed because there has not been any development[27]. Many breaches resulting from spoofing have served as a major threat to domestic security where multiple hackers are stealing financial and personal data. The importance of stack "internet protocol" needs to be considered for addressing such problems. The five parts of the internet stack protocol include the application layer, transport layer, network layer, link, e.g., LANs, and physical layers in descending order.

As per the researchers, spoofers can be classified into three major classes. These include access points, false input, and approach. For false input, there are two

important methods[28]. These include the analysis of signals and manipulation of data. In addition to this, three techniques are used for testing GPS considering the security perspective. The two important approaches include the intrusion of a system for manipulating software in receivers and other GPS-based systems. Lastly, the computer packages are also utilized for simulating such scenarios that attack the host.

8. UTILIZATION FOR BIG DATA STORAGE

The Utilization of Big Data has continued to increase on the part of different research firms. It has contributed to new research trends. On the part of other business organizations, they have successfully adopted recent trends and made progressions for future directions[29]. It has also led to new opportunities. In short, the approaches to decision-making have continued to improve, having a major impact on corporate decisions. If the perspective of GPS applications is taken into account, it is important to realize that these are sensitive to the location alongside the responsiveness in real-time[30]. Considering the prior methods, it is important to know that static data alongside centralized storage make certain imposition for applications requirements in real-time. There is a need to refine the storage for the GPS location data. It emphasizes a limited scope for data storage due to which it is not available in unfavourable scenarios. Now, if the Big Data application is taken into account, considering the location data as "geospatial" data, then the dissemination method holds immense importance. The storage of data is respective to the "NineCell Grid" method. The computation-based aspects are analyzed for analysis and storage where the availability of storage nodes is not considered. In this method, the storage is based on area information[31]. The redundancy of data is used for the improvement of communication. However, HDFS "Hadoop Distributed File System" can easily be utilized for storage. It functions as the distribution of data among 9 nodes. Data is stored only if it follows reduced operations. Otherwise, a single file is stored as copies among the 9 cells. Thus, data storage is such that it doesn't break up into smaller chunks. The main reason for data not being decomposed is that reduced operations can't process all the bits.

9. MICROSTRIP PATCH ANTENNA (E-SHAPE) ARCHITECTURE

Reflecting upon the aspects of Antenna theory, micro strip antennas hold immense importance. E-shape antennas hold tremendous importance if the implementation of GPS is taken into consideration. The performance is such that the L2 application GPS has a frequency of 1227.5 MHz[32]. The frequency coverage ranges from 1200-to 80 MHz Other factors that serve as important parameters include a bandwidth of impedance, radiation patterns, gains, and return losses. For the induction of the local inductive effect, it is important to realize that two slots are placed in parallel connections. The surface current is perambulated between these slots.

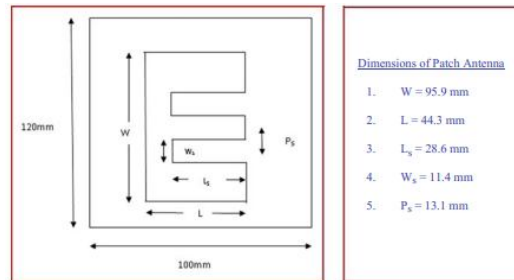The designing architecture of patch antenna is as follows;

Figure 6: E-shape architecture for Patch Antenna[33]

10. SIW "SUBSTRATEE INTEGRATED WAVEGUIDE" IMPLEMENTATION

Regarding GPS design, the SIW technique holds immense importance as it enlightens the productivity-based aspects in multiple ways. Implementing a bandpass filter done through the SIW technique results in compact sizing for the filter[34]. In addition to taking up less size, the filter's performance is also maintained in multiple ways. The productivity base outcome is not compromised in any possible way. However, the 2 important designs are different concerning the physical aspects. The deployment takes place such that two layers contain a 1.6 mm thick substrate of the epoxy dielectric[35]. Some metallic chips are placed in the middle to obtain a narrow bandwidth. According to the design, the central frequency is 1.575 GHz and is also suitable for the GPS application that is being implemented.

11. CONCLUSION

This review paper is a reflection of GPS in multiple domains. The location accuracy and security perspective have massive importance in the paper, where different architectures alongside other aspects like Big Data, Artificial Intelligence, and Fleet Management. The socialized aspects have been discussed where the globalization problem has been enlightened. Moreover, the spoofing aspects have also been taken into account where different types of attacks and mitigation measures have been discussed. Another important piece of literature that has been reviewed enlightens the aspect of the Sierpinski crossover. The positioning phenomenon is a reflection of that. Conclusively, it is important to realize the effectiveness of GPS on part of the general public and the businesses for security purposes and also other different purposes like location tracing.

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