Location Based Service (LBS) Provision: Concept, Benefits and Future Challenges

Eneh Joy Nnenna, Orah Harris Onyekachi

Abstract- It is possible for call rates in mobile phone calls to be charged based on the location a subscriber is calling from. An advert about the use of a product, say a new palm oil milling machine, can be directed and spread only to the farmers in the southern oil palm producing states through location aware advertisement , without the news getting to subscribers in the northern part of Nigeria where palm oil fruits rarely grow. These are the practical applications of the concept of location aware service provision or location based services as the name would appear in different texts. Location based service provision is an extension of the field of the wireless network applications that is relatively new to the Nigerian subscribers and digital marketers in the country alike. This paper does an x-ray analysis of this emerging technology and its challenges, presents its functional architecture, and also looks at the benefits it offers and how it is reshaping businesses in the 21st century.

Index Terms- Geolocation**, GPS** (Global Positioning System), LBS (Location Based Services), MS (mobile Station), and TOA (Time of Arrival)

1. INTRODUCTION

Advancements in geolocation techniques and technological breakthroughs in mobile position estimation have expanded the possible uses of the GSM and other wireless communications networks. This is the outcome of a long-standing interest in developing technologies that could tell very accurately the location of mobile phone users. With the application of an appropriate geolocation technique and the matching positioning algorithm, it is possible to estimate with a high degree of accuracy the location of a mobile phone user. Such location can further be displayed in 2D or 3D coordinates of longitudes and latitudes on a graphical user interface for easy understanding and interpretation by the user of the technology.

There exist many incentives for wireless service providers to have such a system in place. They can use reliable position location as a means to optimize the performance and design of the wireless networks and can also offer additional features to the subscribers. Location based service provision is a feature which enables wireless service providers to use the knowledge of the location of a subscriber to render services that are specific to that location and which touches various aspects of the subscriber's life and business transactions.

The increasing research interests in mobile positioning were motivated by a number of factors. Home zone calls, traffic locating and network planning as well as assistance in handover that the network operators would get from this technology are among the factors. [1]

The fundamental among these motivating factors was the need to meet up with the E911 mandate of the FCC [2]. The 911 service was developed to provide a call forwarding arrangement with a public safety agency. When a 911 call is received by a telephone switch, it is directed to the appropriate public safety answering point (PSAP) over dedicated emergency telephone lines. However, this mechanism was not resulting in the most efficient response time because the public safety answering point (PSAP) handling the call may not be the PSAP nearest to the caller and vital information, such as the caller's location or phone number, was not always available. Thus, a need for a more efficient 911 service was conceived, which consequently lead to the development of the Enhanced 911 (E-911) service.

Although some wireless systems are capable of providing basic 911 services, few provide E-911 service.

The inability of wireless service providers to offer comparable E-911 service has become a major safety issue that concerns the FCC, public safety organizations and the wireless industry.

A caller on a wired telephone to E-911 service is immediately located because the location of the fixed telephone is known with an accuracy of within couple of rooms in a building. If the same caller is on a mobile telephone, there does not currently exist any technology that can obtain the location except that the caller is connected to a particular BS. In order to improve emergency response, the FCC had mandated that all cellular telephones, PCS handheld communicators, and specialized mobile radios should provide geolocation services.

In 1994, the FCC proposed to amend its regulations to address issues raised by the provision of 911 and E-911 service through wireless communication systems [3].

The FCC proposed to adopt rules that would require wireless, in particular commercial mobile radio services that provide real time voice services, to include features that will make E-911 services available to mobile radio callers by October 1 2001. (This date has since been postponed.).

These features include Station Number Identification (SNI), Automatic Location Information (ALI), Selective Routing (SR), and other features for 911 calls provided over wireless systems.

The mandate requires that a public safety answering point (PSAP) be able to locate mobile device to within 50m, for 67 percent of E-911 calls and 150m for 95 percent of the calls if a hand based geolocation technology is used and to within 100m (300m) for 67

percent (95 percent) of calls if network-based geolocation technology is employed.

In the First stage, wireless service providers are required to transmit to the PSAPs, any 911 calls from a handset that transmits a Mobile Identification Number (MIN), or its functional equivalent, without any interception by the carrier for credit checks or other validation processes. This step is to be completed within twelve months of the effective date of the rules. In the second stage, beginning twelve months after the effective date of the rules and ending after eighteen months, wireless service providers must provide a cell-site location mechanism in their wireless systems along with providing the PSAPs with the caller's phone number. If possible, they must also indicate the sector in which the 911 call is received, in case the cell of interest is sectorized. This stage ends near the end of 1997. In the last stage, which should be finished within five years after the rule making, i.e., around 2001, the wireless service providers will have to achieve the capability to identify the location of the mobile unit making a 911 call within a circle of radius of no more than 125 meters in at least 67 percent of all cases. These regulations will affect all present and future wireless communications systems. Wireless service providers are actively looking into techniques and solutions which will enable them to meet the FCC requirements and which will be economically feasible with minimum changes in the existing infrastructure.

Having discussed the motivations for wireless service providers to incorporate position location capability in their cellular systems, in the following section we shall look at the concept of location based services in terms of its areas of application and the benefits. The next section will look at location based services as an emerging technology which could have a great influence on the way mobile services are to be offered in the nearest future and the potential challenges. Finally we shall look at the degree of deployment of these services and an analysis of the prospects of the markets for these services.

2. THE APPLICATIONS OF LOCATION – BASED SERVICES

The term "location-based service" is used to refer to services provided to mobile subscribers based on their geographic location, position, or known presence [4]. These are primarily based on a geolocation infrastructure and system put in place to obtain location information of users. Positioning systems have a wide variety of applications that are already in use today. Such applications include mapping services (that provide driving directions), information services (for making dinner reservations, movie tickets, directory services, etc). Commercially, content, advertising and personalization services that are location dependent are being deployed today. In indoor applications, location-based services are often directed at finding people and assets within buildings and responding to their requests for certain service.

Performance:
This is based on the accuracy of the positioning method that gives different levels of accuracy and hence aims at different market sectors. For example, fleet managers do not require a high level of accuracy, so this method can simply find the nearest antenna to the device. However, emergency services, such as mountain rescue or ambulance services are likely to require more accuracy, such as determining the distance that the device is away from several antennas.

Complexity
Sometimes combining and deploying two or more location technologies gives results that are more accurate. These positioning technologies can be grouped under complexity, and are commonly known as hybrid systems.

Implementations requirements
Some implementations require extra implementations in the existing systems to achieve some degree of accuracy, such as in the software requirements of the handsets, or in the hardware requirements of the mobile network.

Investment
This is a major factor, and it depends on the amount of additional services that the network can provide for in the future, and their required level of accuracy [5].

3. LBS ARCHITECTURE: How LBS Works

The diagram below show a functional architecture of a Geolocation system which forms the backbone of every location based service. The mobile subscriber and the measured parameters it shares with the network form the two most functional entities needed for position location. A system like the one shown in figure 2.1 below measures the parameters of radio signals that travel from a mobile terminal to a fixed set of receivers, or from a fixed set of transmitters to a mobile receiver. The actual estimate of the location of the MS can be done in two ways:

(a) Through self-positioning; in which case the MS locates its own position using measurements of its distance or direction from known locations of transmitters (GPRS receivers for instance). Self-positioning systems are often referred to as mobile-based or terminal-centric positioning systems.

(b) Remote-positioning. In remote positioning systems, receivers at known locations on a network together compute the location of a mobile transmitter using the measurement of the distance or direction of this mobile from each of the receivers [6]. Remote

positioning systems are also called network-based or network-centric.

Network-based positioning systems have the advantage that the MS can be implemented as a simple transceiver with small size and low-power consumption for easy carrying or attachment to valuable equipment as a tag. In addition, it is possible to have indirect remote or self-positioning systems where the mobile system may transmit information about its location to a location control center, or the location control center transmits the location of each mobile system to itself through an appropriate communications channel.

The figure below shows an example of geolocation system architecture.

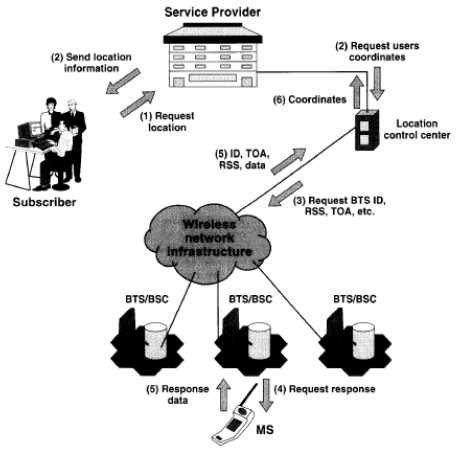

Fig 1.*Mobile location system architecture*

The location of an MS can be determined as follows. Let us consider, for example, a remote-positioning system where the BSs are together determining the MS's position. A similar approach is applicable for self-positioning systems. It is possible to exploit characteristics of radio signals transmitted by an MS to fixed receivers of known locations to determine the location of the MS. The BSs measure certain signal characteristics and make an estimate of the location of the MS based on the knowledge of their own location. The general problem can be stated as follows:

> The location of N receivers (BSs) are known via their coordinates (X_i, Y_i) for I = 1, 2, 3…, N. using characteristics of the signal received by these transmitters.

Clearly, in order to determine (X_M, Y_M), the distance or direction (or both) of the MS must be estimated by several of the BSs from their received signals. Distances can be determined using properties of the received signal such as the signal strength, the signal phase, or the time of arrival. The direction of the MS can be determined from the angle of arrival of the received signal. Upon a request from the subscriber for location information about an MS, the service provider will contact a location control center querying it for the coordinates of the MS. This subscriber could be a commercial subscriber trying to track a mobile device or a PSAP trying to answer an E-911 call. The location control center will gather information required to compute the MS's location. This information could be parameters such as received signal strength, BTS ID, TOA of signals, and so on. Once this information is collected, the location control center can determine the location of the mobile with certain accuracy and convey this information to the service provider. The service provider will then use this information to visually display the MS's location to the subscriber. Sometimes the subscriber could be the MS itself, in which case the message and architecture will be simplified, especially if the application involves self-positioning.

In indirect remote positioning, an E-911 PSAP requires the location information of a caller. If a mobile –based positioning system is used, the MS determines its own position either using GPS or signal from multiple BSs. This information has to be transmitted to the location control center by the mobile terminal through one of the BSs

4. BENEFITS OF DEPLOYING LOCATION BASED SERVICES.

LBS Systems will provide wireless carriers and vendors who use position location the ability to charge for service based on location, within a particular cell site, or in a specific location such as an office, home, or car. This will allow wireless service providers to control customer usage by offering cost incentives that match service plans for the wireless infrastructure and networking resources.

Position location services will not only provide new customer options and products for wireless carriers, but will also provide features that could differentiate services in different markets (i.e., differentiation between PCS, cellular, and specialized mobile radio) [4].

Geographical information about the service usage will also enable the service to have real-time information about areas having concentration of usage and such information will facilitate cellular planning. It will also be easier to locate the sources of fraudulent cellular telephone traffic and fraud 911 calls and thus the business loss which results from fraud can be reduced.

Location information of mobile users can also be used to increase the hand-off efficiency. Design of efficient hand-off algorithms is an important issue in cellular

design [5], and position location information may help in avoiding unnecessary hand-offs that may result because of local fading [6] and hence may help reduce the processing load.

With the introduction of new PCS service providers in the wireless communication market, increased competition is expected between the service providers to attract the customers. Position location capability may be offered as an additional service to the customers, along with the standard voice services. This may allow the position of any user to be traced at any given time, if requested. However, some customers may still not want this feature for the sake of privacy.

Automated position determination will also help in providing emergency road-side services quickly and efficiently. Position location systems may also be very helpful in fleet management and can be used for traffic routing and scheduling of vehicles in real time [4]. Intelligent transport systems (ITS) refer to the ability to automatically navigate vehicles while making use of the latest traffic information, road conditions, travel duration, and so on [5]. This includes fleet management as well as the automatic steering of vehicles. In order to obtain relevant information from service providers or servers across a network or the internet, the vehicle should be able to provide their location and destination information. Alternatively, the service provider should be able to determine the vehicle's location. There can also be a number of potential applications of position location systems for in-car navigation systems and for direction finding from known position to given destinations.

Apart from the above cited advantages, law enforcement agencies may benefit considerably from such systems which may be used to increase their crime fighting capability [6].

Real-time position location may be used to track the location of officers and agents. Such information may also be used to track suspected criminals and to recover stolen vehicles. Hence, addition of position location information to the existing services being offered by the wireless service providers will be encouraged by a wide section of the customers. Therefore, the wireless service providers can safely assume that they can find a market for position location information if they invest in installing such systems.

5. LBS MARKET DIVERS AND CHALLENGES

There are many obstacles in the development of location-identification technologies. Cost is one issue. In the case of satellite-based services, such as those supported by GPS technology, the relative cost to the user is high as enhancements must be made to the handsets. Standardization presents other challenges. In accordance with the E911 Act, each wireless carrier must be able to identify the location of the user. The carriers have the option of choosing the technology used to provide this information. Because there is no one standard, the ability to locate a user becomes a proprietary effort, challenging seamless location identification as users move from place to place. There is also the issue of privacy. Individuals will not be happy when information about their location at any point in time is easily accessed by network service providers. However, proper regulations are being put in place to prevent such problems.

The following factors form the basic motives for the deployment of location based services by wireless network operators:

I. Supports focus on long term value creation
II. Increased consumer awareness of location-based applications
III. Competitive pressures driving operators to seek service differentiation
IV. High-speed data networks and enhanced handsets enable more sophisticated LBS capabilities
V. Threat of internet players e.g. Google, Yahoo having great success in wired world [7]

On the other hand, the following factors pose a big challenge to this emerging technology.

I. High cost of geolocation technology can slow down rollout of A-GPS handsets.
II. No single location technology can optimally address all calling environments.
III. Privacy concerns are also affecting both supply and demand for the services.
IV. Limited user awareness of LBS benefits, Changes in business strategies, Investment risk, limitations in mobile devices, networking problems, infrastructure constraints, security concerns, and a general User distrust of mobile applications.

6. LBS FUTURE

In the future, a convergence of technologies is expected to change the way location-based services are offered to consumers. It is likely that a single handheld device will serve as a phone, computer, television, radio, and PDA. Java will facilitate this convergence and allow for the proliferation of location-based services for each of these devices [8].

Smart spaces and smart office environments are being considered for deployment that can automatically change their functionality depending on the context. Such context-aware networks are based on awareness of whom or what is present around them. With location awareness, computing devices ranging from small PDAs to desktops and internet appliances could personalize and adapt themselves to their current set of users, each requiring their own services from the smart environment. For this purpose, not only should the smart space be aware of who is present, but it should also be

aware of where the user is located and whether there are other mobile devices in the vicinity. For example, a hand held computer should be able to automatically determine the closest printer to print a document in an office environment.

Projected annual US LBS revenues will reach $3.5B by 2013 with approximately 46 million subscribers [9]

REFERENCES

[1] Isaac K Adusei, K. Kyamakya, Klaus Jobmann, "Mobile Positioning Technologies in Cellular Networks: An Evaluation of their Performance Metrics", University of Hannover Institute of Communications Engineering Hannover – Germany.

[2] Jim Costabile," Wireless position location", Virginia Tech Wireless Symposium June 4, 2010.

[3] Hakan Senturk, First Lieutenant TUA; "Performance evaluation of hyperbolic position location technique in cellular wireless networks" thesis work, AFIT/GCE/ENG/02M-03

[4] Jim Costabile, "Wireless position location", Virginia Tech Wireless Symposium June 4, 2010

[5] W.J Buchanan, J.Munoz, R.Manson; "Analysis and Migration of Location-Finding Methods for GSM and 3G Networks", School of Computing Napier University Edinburgh, UK

[6] Gregory D. Durgin, "Radiolocation in Cellular Networks", Georgia Institute of Technology

[7] Jim Costabile, "Wireless position location", Virginia Tech Wireless Symposium June 4, 2010

[8] A. Roxin, J. Gaber, M. Wack, A. Nait-Sidi-Moh "Survey of Wireless GeolocationTechniques", LaboratoireSystemeset Transports (SeT)

[9] "E911 and LBS Addressing the New Location Accuracy Gap", Frost & Sullivan

http://www.tkn.tu-berIin.de/curriculalss03/vlkts/zusaetzelUMTS location .pdf

http://www.webmap.o2.co.uk

Ahonen S., UMTS location for network planning and optimisation in urban areas, http://www. vtt.fi/tte/tte35/pdfs/ahonen Lobster workshop. pdf.

Author Eneh Joy Nnenna is currently pursuing a PhD in Electrical and Electronic Engineering in Nnamdi Azikiwe University Awka, Nigeria, PH- 2348064811235. Email: enehjoy@yahoo.com

Co-Author Orah Harris Onyekachi is currently pursuing a Masters Degree program in Electronic Communication Engineering in the University of Nigeria Nsukka, Nigeria. PH-248039117995
Email: hariteks@yahoo.co.uk