LOCATION BASED SERVICES (LBS) AND RELATED STANDARDS

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ABSTRACT:

Nowadays, mobile network operators try to create the novel services in order to increase advantages of existing telecommunication services. Providing many personalized services for mobile phone users is one of the best ways for achieving this. Location is the most important of personalized services. LBS are vital for our life which contain a lot of considerable topics such as emergency services, navigation and security.

Wireless internet users are continuously increasing. Many people are aware of the wireless internet technology. However, a few of them know the personalized services for LBS. They have provided the services in many fields such as health, security, entertainment and disaster management. Therefore, usage of these services will be common in future. In addition, LBS have extremely facilitated the life of many people. LBS have the properties such as providing the location information and determination the location of mobile devices. There are different methods for determining the location in LBS. These methods have different location accuracy.

LBS have to have the standards in order to provide the interaction among the services. Open LS (Open Location Service) creates the specifications for interoperability of location application services. Open LS has studied to create the standards with OGC (Open Geospatial Consortium) and ISO TC/211 (International Standardization Organization Technical Committee). As a result of this, ISO 19133 Geographic Information-Location Based Service-Tracking and Navigation Standard was issued on 21.10.2005.

This study considers the important subjects such as LBS, location determination methods and creating the standards between location services. Moreover, it mentions about future of LBS, economical size of LBS and importance for our life of LBS.

1. INTRODUCTION

Recently, there is a significant competition in telecommunication field. In order to increase the profits in this field, mobile network operators have started to present the novel services. One of the best way to accomplish it is delivery the users personalized services. Location information is one of the most important among them.

LBS are an information service which provide the location information using location determination technologies (LDTs) for users. According to OGC (Open Geospatial Consortium), A wireless-IP service that uses geographic information to serve a mobile user. Any application service that exploits the position of a mobile terminal (OGC, 2003).

Geographical data is the most important component of LBS. GIS provide the tools to supply and manage base map data such as streets, buildings, mountains and rivers. GIS is also used to manage point-of-interest data such as location of gas stations, restaurants, nightclubs, etc. As a result of obtaining the information by GIS, functionality of LBS increases.

Determination the location of the mobile user is not enough on the digital map in LBS. There must be a location management function (LMF) to process the location information on behalf of LBS applications. LMF acts as a gateway and mediator between positioning equipment and LBS infrastructure.

Many people use the wireless internet. However, most of them are not aware of importance and potential of personalized information services. One of the best way for personalized of information services is activated to be location based. We assume that anyone would be using Wireless Application Protocol (WAP) via mobile phone while searching a restaurant for eating. The LBS application would interact with other location technology components to determine the user's location and provide a list of restaurants within a certain proximity to the mobile user. It is given in Figure 1. In addition, LBS are also used to facilitate the our life in fields such as location based billing, emergency services and tracking services.

Figure 1. Access the location information service via WAP

2. LOCATION DETERMINATION TECHNOLOGIES (LDTS) FOR LBS

LBS refer to mobile services. GPS technology is used for most different fields which is one the most obvious technology for LBS. Generally, LBS are based on wireless LDTs which are either terrestial (a limited operational area) or spatial (Global navigation system) (Tomko, 2003).

Terrestial LDTs are represented by different methods to determine the position of the mobile device in the wireless communication operator's networks. It is based on computations done in the handheld device or by the network's LMC (Location Measurement Center).

Global Navigation Satellite Systems LDTs are represented by Nawstar GPS satellite based Global Positioning System and emerging Galileo system of the EU (Tomko, 2003).

It is possible to determine the location with different methods for LBS. However, these methods have different accuracy level. We can investigate the LDTs in two fields such as Network Based-Hybrid and Mobile Unit Based.

2.1 Network Based and Hybrid LDT (Active Network Technology)

These technologies use the network of the operator to determine the location of the mobile device. All mobile telephone networks that are used and are built the same way: The network is organized in cells around the antennas of the BTS, which connect the user terminal to the global telephone network (Hjelm, 2002).

2.1.1 Cell-ID Method

Probably, Cell-ID technology is the easiest way to determine of the location in LBS. It is based on the information of the BTS (Base Transceiver Station) serving area, where the MU (Measurement Unit) is operating. Both the position of each BTS and serving area of them are well known in a defined reference system. Precision of this technology is relatively low. However, its great advantage is that location information is immediately obtained without extra process in mobile device.

When a mobile phone is switched on, it makes contact to the nearest BTS. Therefore, all the mobile phones are automatically located with the accuracy of the cell size. The radius of the cell size can be a few hundreds meters in urban area, or as larger as 35 km in the rural area for the GSM network (Chen, 2005).

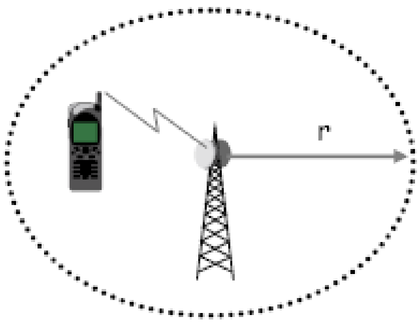

Figure 2. The Cell-ID method (Chen, 2005)

2.1.2 Angle of Arrival (AOA) Method

AOA is based on the signal directions (azimuth) measured at multiple BTSs. A direction is measured by using an array of 4-12 antennas placed at the BTS. The antennas array requires the received signal (from the mobile device) to be at an appreciable level. Two or more azimuths are needed in order to determined the location of the mobile station. An additional antenna array is required for each BTS. Therefore, modification in the network-side is needed. However there is no need to modify the handset.

The accuracy of the AOA technique is limited by the beamwidth of the antenna array. The typical error is about 300 meters (Chen, 2005).

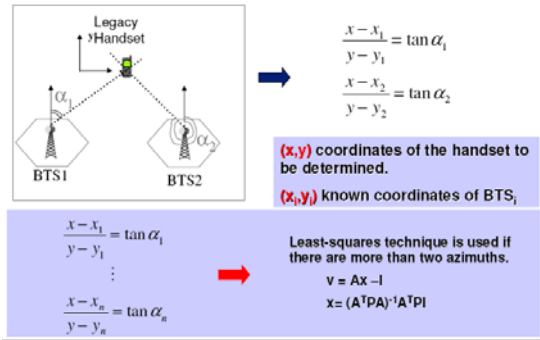

Figure 3. The AOA method (Chen, 2005)

2.1.3 Timing Advance (TA) Method

In order to determine the location of a mobile station, at least three TA parameters from different BTSs are required at a time. Therefore, the mobile station is forced to make two or more positioning handovers to the BTSs in its surroundings for obtaining additional TA parameters. At each positioning handover, the TA value is measured on access bursts and the value is reported to the network element (e.g. the MLC) that is responsible for location estimation. The neighbor BTSs do not respond to the mobile station. In addition to this, the mobile station returns to the serving BTS after the positioning handovers. In case the mobile station is in the idle mode, a call to the MS is needed in order to obtain the TA parameters.

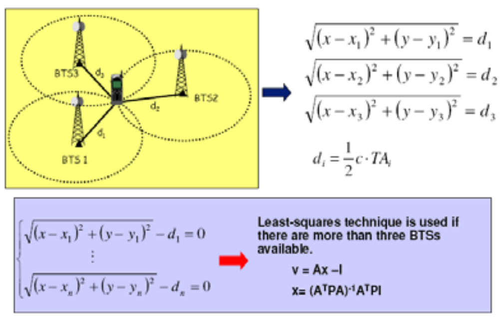

Figure 4. The TA method (Chen, 2005)

The TA technique is a network-based technique. The measurement is performed in the network side. No modification is need for the mobile station. Thus, it can be used for locating legacy handset. Accuracy of this method is about 550 meters (Chen, 2005).

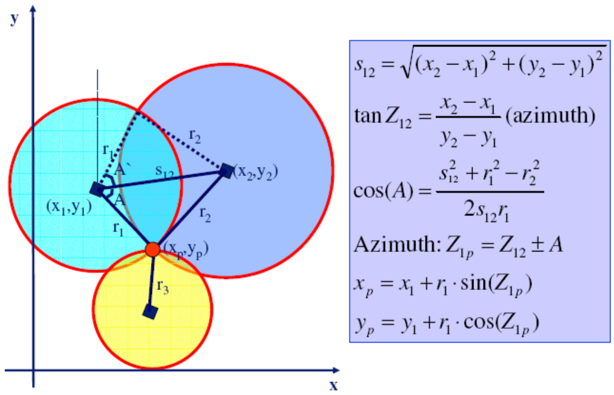

Figure 5. Triangulating the location of the mobile phone with three TAs (Chen, 2005)

2.1.4 Uplink Time of Arrival (U-TOA)

This technology is the most precise among network based technology. The network is enforced with Location Measurement Units (LMUs) in this technology. Difference in the time of arrival of the signal from the mobile device to more than one BTS is used to calculate the location of the device. This needs synchronisation of network using GPS or atomic clock at each BTS. By measuring the signal from the mobile phone, position of the user can be determined with a method based on trilateration.

The advantage of the method is a high level of the precision and the compatibility with any mobile device. However, the equipment of the network must be modified significantly. A number of LMUs must be installed. The activity of at least 3 LMUs is needed for position determination. While TOA is more precise than Cell-ID method, it is expensive because of the large number of LMUs required. The U-TOA method was designed as the method to fulfill legal requirements of the E911 standart in USA. This expects a positioning of all the emergency calls with the precision in location determination of at least 125 meters with a reliability of 67 % (Tomko, 2003).

2.1.5 Time Difference of Arrival (TDOA) Method

The TDOA technique is based on the uplink TOA technology. The mobile station acts as the transmitter, and the LMUs at BTSs act as the location receivers. The mobile station transmits a uniform signal that can be detected by a number of LMUs at the BTSs. When a signal is detected, the LMU 'time-stamps'the signal in order to identify the time when it was first detected.

The difference for two TOA measurements can be calculated. Each time difference is equivalent to a range-difference, which forms a hyperbola. Two hyperbola lines can be formed with three time stamps from three different LMUs. The position of the mobile station can be determined by triangulating the hyperbolic lines. At least two hyperbolic lines are needed in order to determine the location of the mobile station.

With TDOA, all LMUs should be synchronized their clocks across the network using timing source either from atomic clock or from GPS information.

The TDOA is a network-based technique. The mobile station just transmits a unique signal; it does not perform any measurements. Therefore it works fine with the existing legacy handsets because no modification is needed for handsets. The positioning accuracy of TDOA is about 100-200 meters.

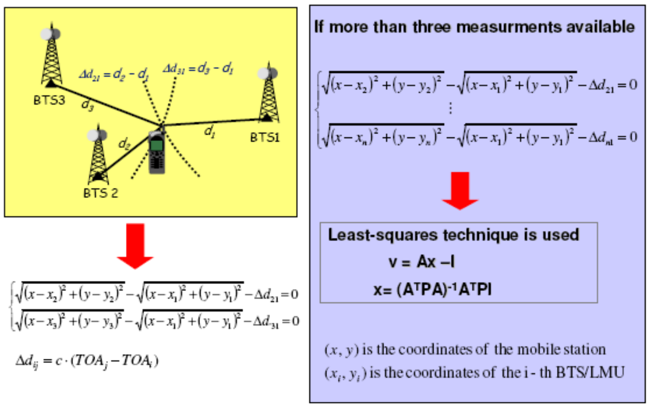

Figure 6. The TDOA method (Chen, 2005)

2.1.6 Round Trip Time (RTT) Method

The RTT measurement has been proposed for UMTS (Universal Mobile Telecommunications Systems) network. It is similar to the TA parameter in the GSM network. It is the round trip signal propagation delay between the mobile station and the BTS. The accuracy of the RTT measurement is much higher than that of the TA measurement because the chip period in UMTS system is approximately equivalent to 80 meters, while the bit period in GSM system is approximately equivalent to 1100 meters (Chen, 2005).

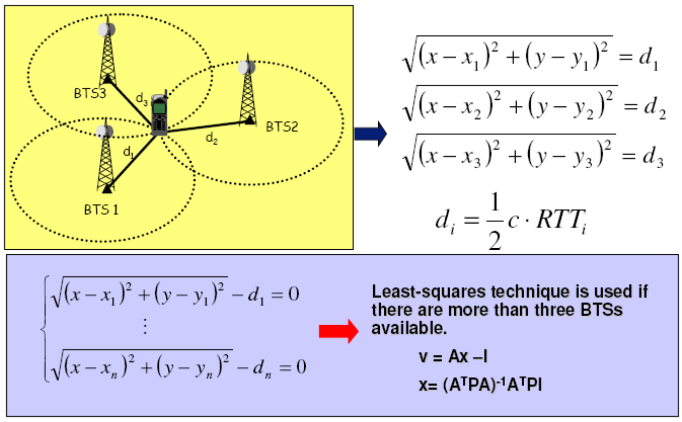

Figure 7. The RTT method (Chen, 2005)

2.2 Mobile Unit Based LDT (Passive Network Technology)

The positioning is performed in the mobile device via synchronized signals, emitted from BTSs or coming from GPS. A modified mobile device is needed (Tomko, 2003). It is needed the modified device in this method. We can divide to two main category the technology such as Enhanced Observed Time Difference (EOTD) and GPS/Assisted GPS (A-GPS).

2.2.1 Enhanced Observed Time Difference (EOTD) Method

EOTD is based on measurement the time of the signal arrival from multiple BTS (within the wireless network) at the mobile device. The time differences between the signal arrivals from different BTSs are used to determine the user's location with respect to BTSs, provided that coordinates of BTSs are known and the BTSs send time-synchronized signals. For the positioning and timing purposes, the BTSs might be equipped with stationary GPS recievers. Thus, BTSs serve as reference points in this method. It is similar to GPS satellites. However, this method is not subject to limitations in signal availability affecting GPS (Karimi and Hammad, 2004).

Accuracy of this method is about 60 meters in rural area and 200 meters in urban areas. Since EOTD requires monitoring equipment at virtually every base station, cost of this method is expensive for LBS. However, it is cheaper than TDOA.

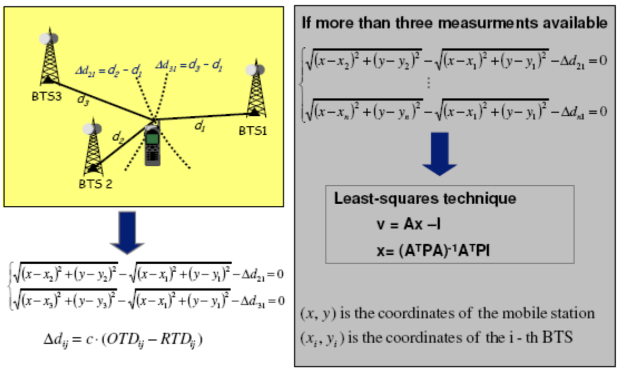

Figure 8. The EOTD method (Chen, 2005)

2.2.2 GPS and Assisted GPS (A-GPS)

The system consists of

- A new generation of handset that includes a partial GPS receiver,
- An A-GPS server with a reference GPS receiver. The A-GPS server can simultaneously "see" the same satellites as the mobile station to be located, and
- A cellular network infrastructure.

The network infrastructure provides a rough position of the mobile station, at the level of the cell size, to the A-GPS server. The A-GPS server uses this information to predict the GPS signal the mobile station will receive, convey it as assistance information, and send it to the mobile station via the network infrastructure (Chen, 2005).

A-GPS method determines the position using GPS and GSM networks. It is an expensive method for end-user due to the fact that GPS receivers are embedded inside cellular phone to determine the position of itself. It is obvious that the modifications are needed both in the mobile station and the network infrastructure in order to provide the A-GPS location services. The positioning accuracy of the A-GPS receiver is ±3 meters for rural area, ±5 meters suburban area and ±50 meters urban area.

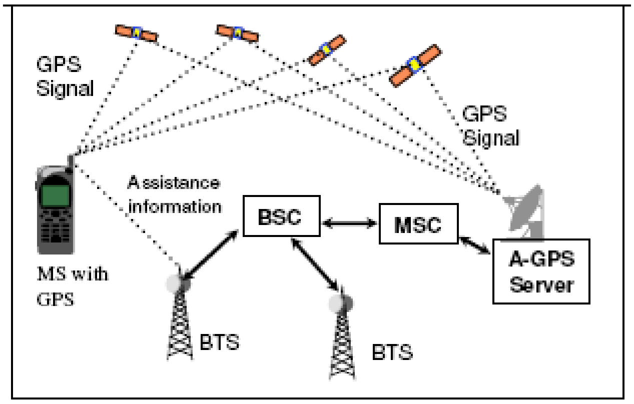

Figure 9. The A-GPS method (Chen, 2005)

3. STANDARDS FOR LBS

The Open Location Services Initiative (OpenLS) is devoted to the development of interface specifications that facilitate the usage of location and other forms of spatial information in the wireless internet environment. The purpose of the Initiative is to produce open specifications for interoperable location application services that will integrate spatial data and processing resources into telecommunications and internet services infrastructure. The goal of OpenLS is to accelerate the availability of robust location services that respond to diverse market needs (OGC, 2005).

3.1 Mission Of The OpenLS

OpenLS encourages to try together key industry players to create and consolidate the standards infrastructure for interoperating location-based software services. Its mission is to specify standard interfaces and protocols. Furthermore, developers can use to integrate geospatial data and geoprocessing resources into location services and telecommunications infrastructure. They also demonstrate these capabilities with different applications for consumers, businesses and governments. It is called as the GeoMobility Server Platform.

Location Services are used in many different fields. Location Services have to be integrated to provide the standardization of them. This will require to study together of many companies. This value chain will profit for end users. Companies in the value chain will include:

- Wireless carriers and Internet service providers who buy and use systems.
- Companies providing location technology products.
- Platform developers whose middleware connects telecommunications service infrastructure LBS applications.
- Application developers providing applications.
- Data providers and consultants who provide location-based content (OGC, 2005).

Location Services will depend on open, non-proprietary standards that work in all of the world such as the Internet, the World Wide Web, the Global Telephone Network and fax machines. Huge markets will form countless vendors. They will build the commercial brands, proprietary products and services on a standard infrastructure.

OGC provides a unique environment to specify, build, test, and evaluate the prototypical location service. Testbed Sponsors and Participants search that what is necessary to create confidently commercial solutions for Location Services.

3.2 Combining Spatial Standards and Communications Standards

In order to create the Location Services on internet, web and wireless environment, OGC works closely with Location Interoperability Forum (LIF), MAGIC, ISO TC211, TC/204, WAP Forum, IETF, AMI-C and W3C. Specifications of these groups must be consistent with specifications of the groups such as Parlay, Third Generation Partnership Project (3GPP), GPP2, European Telecommunications Standards Institute (ETSI), and the Telecommunications Industry Association (TIA). OGC invites interested organizations to join the OpenLS Initiative as sponsors or participants. This accelerates to meet with qualified mobile services of mobile users. Standards Framework creates the OpenLS Standards which is given in Figure 2 (OGC, 2005).

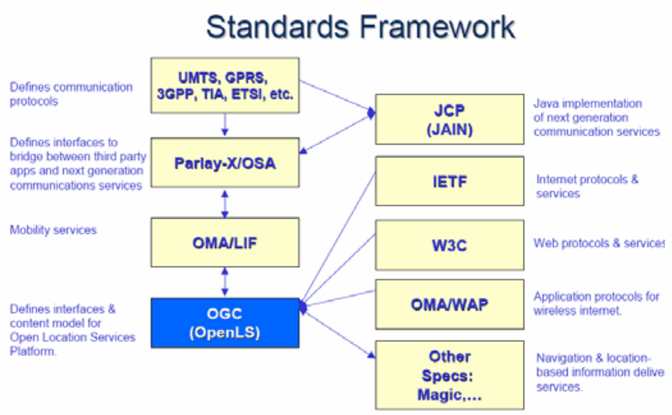

Figure 10. Standards Framework (OGC, 2004)

3.3 The OpenLS Core Services

The basic services that comprise the open service platform (GeoMobility Server) defined under OpenLS (OGC, 2004). The OpenLS Core Services are location based application services. Specifications related to these services are given in Figure 3.

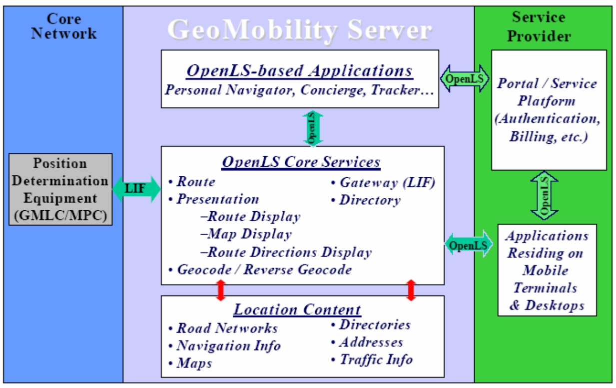

Figure 11. Geomobility Server (OGC, 2004)

Geomobility Server uses the WGS 84 coordinate system. Accepted standards related to coordinates are as follows.

- Default Coordinate Reference System - WGS 84;
- Coordinate Order - Latitude, Longitude;
- Value Type - Decimal Degrees;
- Latitude Sign is +90 at North Pole to -90 at South Pole;
- Longitude Sign is -180 west from Greenwich at the International Dateline to +180 east from Greenwich at the International Dateline (OGC, 2004)

The OpenLS consists of "Core Services" as follows. In addition to this, The OpenLS Information Model is given in Figure 4.

- Gateway Services that integrate OpenLS location application services with position determination equipment in the MPC/GMLC,
- Directory services for searching yellow pages, green pages, travel guides, and so on,
- Route determination services for navigation,
- Geocode (address to X,Y)
- Reverse geocode (X,Y to address) services,
- Map/feature display services (OGC, 2005).

The OpenLS Information Model

Position ADT	Point location in well-known coordinate system
Address ADT	Street address or intersection
Point of Interest (POI) ADT	The location where someone can find place, product or service
Area of Interest (AOI) ADT	A polygon, bounding box or circle used as a search template
Location ADT	A location (Position, Address or POI)
Map ADT	The portrayal of maps and feature overlays (routes & POI)
Route Summary ADT	Metadata pertaining to a route
Route Geometry ADT	Geometry data for a route
Route Maneuvers ADT	Navigation maneuver data for a route
Route Directions ADT	Turn-by-turn navigation instructions for a route

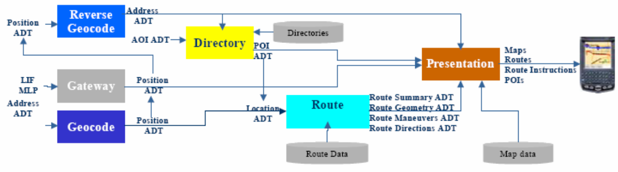

Figure 12. OpenLS Information Model (OGC, 2004)

Standardization related to LBS has been formed by ISO TC/211. In addition this, ISO 19133:2005 Standard was issued as titled "Geographic Information-Location Based Service-Tracking and Navigation" by ISO TC/211. The standard defines the data types and processes related to these data for implementing the tracking and navigation services. It was also designed to determine the web services.

4. PRESENT AND FUTURE OF LBS

LBS include the significant topics for our life such as health, security, entertainment and disaster management. They have provided the benefit both consumers and network operators. Consumers demand to have the properties such as more safety, more personalized services and increasing communication facility. However, network operators have had the leading role in purse services based different marketing fields.

According to a poll of IDC (Integrated Data Communications) in USA, two per third of Americans have preferred the LBS in order to solve the security issues such as emergency call, roadside assistance, and driving directions. Therefore, they have desired the wireless LBS (Prasad, 2005).

The Strategis Group predicts that market size of LBS will be $3.9 billion by 2004 in USA. Named “Location Based Services: A Strategic Analysis of Wireless Technologies, Markets and Trends” report of Allied Business Intelligence Inc (ABI) indicates that world LBS revenues will grow from approximately $1 billion in 2000 to over $40 billion in 2006. This growth will represent a compound annual average growth rate of 81%. For the Asia-Pacific market, Strategic Groups say that wireless internet users will reach 216.3 million by 2007. This means to increase a ten-fold of the 20 million users in 2000 (Prasad, 2005).

5. CONCLUSIONS

Importance of the LBS has increased continually. LBS are a indispensable component of network operators due to having the significant privilege as determining the location of the mobile devices. Nowadays, LBS have provide many facilities for consumers. Economical size of these services has reached a significant level. Because, LBS present the people the personalized services in many important fields such as health, security, entertainment and disaster management. Disaster management is a very important for people. Therefore, usage of these services will commonly develop to affect positively the life of them.

There are different methods to determine the location of mobile devices for LBS. Each of them has different location accuracy. One of the location determination methods can be used in direction of our purpose. Although network based technology is cheaper than mobile unit based method, it has less accuracy than another technology. However, mobile unit based technology is more expensive than another technology, it is also more accuracy than another technology.

The OpenLS has worked to create the standards with OGC and other organizations. Its purpose is to create the specifications for interoperability of the location application services. Its goal is to answer the marketing requirements, accelerating the accessibility the location services. As a result of this, ISO/TC-211 19133 Standard was created which has provided better utilities for LBS users.

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