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Location Based Services

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Introduction

Location based services (LBS) designates any telematic service using location information. LBS is the capability to find the geographical location of the mobile device and then provide services based on this location information. Many different kinds of services based on the availability of location information already exist or could be implemented in the near future. However the mobile operators seem not to be interested in investing to expensive infrastructures, but prefer to use Cell ID or signal level methods.

The implementation of location-based services raises legal issues mainly connected to consumer's rights, privacy, database management, liability and financing. The peculiarity of Emergency Call Services affects the rights for life and health protection, override right for privacy. Particular attention must be put in the location information databases management and updating and to protect user information from unauthorized access. The provision of location data by the telecommunications operators to emergency service authorities and the access to Emergency Call Services by users disconnected for non-payment are also critical aspects to be investigated. Cost sharing is an important open issue especially for Emergency Call Services, which involve several players.

Several companies in Lithuania provide LBS based on Global Positioning System (GPS). Location information of individuals receives are transferred by GSM or Satellite networks. The overview of various location solutions such GSM and others technology represents in this paper.

GSM based location methods

Several techniques for obtaining mobile location are currently being developed and tested future (Table 1). The simplest approach for mobile location is to use only the information of the serving cell (Cell ID). This method is used in the most of the commercial services so far. However, the accuracy depends strongly on the cell size and is not sufficient for many applications. The signal level [1], database correlation method [2,3] and pattern recognition [4] methods are based on measuring the received signal levels at the mobile. Since these are typically measured anyway by the mobile phone, the techniques do not require additional functionality of the terminal or the network. Each technique involves some computations at the network side, which require rather strong computing power when large number of terminals has to be located.

Enhanced observed time difference (E-OTD) [ETSI TS101 724] and time of arrival (TOA) [ETSI TS101 724] methods are based on measuring time delays between the base station and the mobile. These techniques yield rather good performance in open areas, but suffer from multipath propagation in urban areas. The other drawback is high implementation cost due to required enhancements of the network infrastructure. Also signature matching [5] and angle of arrival (AOA) methods [ETSI TS101 725] require considerable enhancements to the base station equipment and are therefore rather expensive to implement.

Table 1. LBS technologies

Handset based solution	Network based solution
Satellite positioning methods	
GPS, GLONASS, DGPS, Galileo	
Cell based location methods	
E-OTD(MB), OTDOA (MB), A-GPS (MB)	CELL-ID, TA, RTT, E-CGI, TOA, AOA, E-OTD (MA), OTDOA (MA), A-GPS (MA), Database Correlation, Location Pattern Matching
Other technologies	
Bluetooth, UWB (RTD	WLAN, UWB (TDOA), DTV

Satellite location methods

GPS receiver integrated to the mobile phone yields good location accuracy. The network assisted GPS technique (A-GPS) takes advantage of satellite information provided to the terminal via the cellular network [ETSI TS 101 724]. In initial tests this technique has been reported to enable increased coverage and accuracy.

GPS is originally designed as an outdoor positioning system. However, in some cases also limited indoor use is possible. By using the A-GPS techniques the dynamic range can be increased based on the longer integration time of the satellite signal. This is possible, since the navigation message is received via the cellular base station (BTS) and can be discarded when receiving the satellite signal.

However, the attenuation of buildings is very high especially in the inner parts of buildings and GPS coverage is possible typically only in small houses. The commercial development in this area is rather slow, largely due to lack of standards.

Galileo, the European global navigation satellite system, is expected to start with four satellites in 2006, and offer the full commercial service with 30 satellites in 2008. It will deliver real time positioning accuracy down to the meter range [6].

Indoor location methods

In indoor use, cellular location techniques, such as the E-OTD method, are typically capable of providing the building or block of buildings where the mobile terminal is. More precise location information is available only if there is a network of indoor base stations. Even in this case, the time delay techniques suffer from limited measurement accuracy relative to the building dimensions. For example, in GSM the symbol length is 3,7 μs. The obtained distance measurement accuracy is then of the order of 50 m, assuming that time delay can be measured at the accuracy of 5 % of the symbol length. This is a substantial error concerning positioning within a building. Instead of time delay techniques, the signal level and correlation methods are more attractive approaches in buildings with indoor base stations.

Increasing the density of indoor signal sources can enhance the indoor location accuracy. Wireless Local Area Networks (WLAN) typically consists of a dense network of access points, which offers good possibility for signal level positioning [7]. Test results for signal level method showing accuracy of 2-4 metres have been reported in [7]. Ekahau Inc. is developing correlation based techniques and claims accuracy of the level of 2 meters [http://www.ekahau.com]. It is clear that the accuracy with both techniques is highly dependent on the access point network density and topology.

Other signal sources can also be used. Bluetooth is a short range technique essentially designed for connecting mobile phones with computers and other equipment [http://www.bluetooth.com]. As in the case of WLAN access points, a network of Bluetooth transceivers can provide indoor location capability. In this case, the additional advantage would be the operation without the need of a WLAN terminal - mobile phone with a Bluetooth module would be sufficient.

Implementation process of LBS

In the process of developing LBS are involved mobile network operators and the companies that produce the equipment and software. The major players of that process presented in fig. 1.

Mobile network operators have almost reached the same trust level as a bank, which is a very important success issue when it comes to the privacy and content quality issues. Application providers and content suppliers will have a key role in delivering sticky services. 3rd party content providers for instance for supplying maps will provide quality of content for dynamically changing information. Infrastructure and handset suppliers will bring new devices with integrated positioning capabilities whilst PDA manufactures will use a certain time frame to integrate a telephony user interface to their devices as major handset vendors will integrate PDA´s functionality into their products.

The positioning technology companies themselves have the most to gain, but also the most to lose from a rapid resolution to this question. Resolution will probably come through a single technology (or at the most from two or three) being adopted as the 'winner'. Location technology companies that have backed a losing approach, and whose primary asset is the intellectual property associated with it, may find that they become close to worthless overnight – unless they have other lines of business.

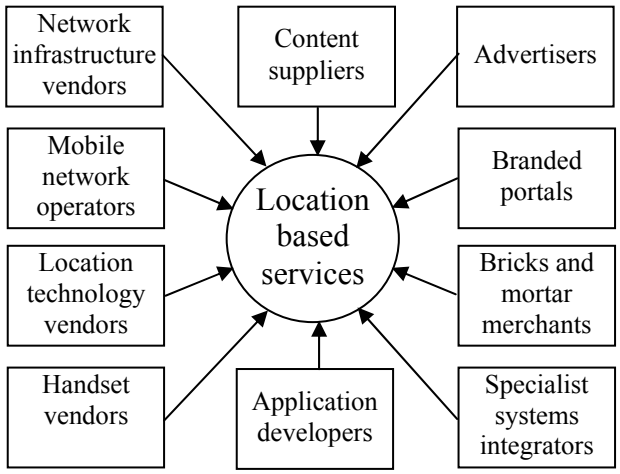

Fig.1. The major players of developing LBS

Mobile network operators also have much to gain from the deployment of mobile location services. At the very least, it should stimulate more data traffic on their networks, and perhaps more voice traffic too. At best it may help them to regain the loyalty of their customers by offering them indispensable services and by binding them into network-based communities through 'find a friend' services.

Handset manufacturers stand to gain from the opportunity to make and sell a new generation of products that incorporate location capability. This is particularly important for the market leaders, who must constantly seek new areas of differentiation in the face of commodity suppliers of voice-centric and basic devices.

Device-based solutions, where the position determination is carried out by functionality within the mobile, might appear to offer them the greatest opportunity, although it also carries the risk of having to pay royalties or license fees if the manufacturer has no control over the winning technology. Device based approaches also offer the possibility of the handset manufacturer (rather than the network operator) being able to offer the location services themselves.

Application developers are main part of the location services implementation chain. There are many opportunities for innovation and the creation of value. Many applications are more or less agnostic on positioning

technology, and developers have a lot to gain whichever solutions are adopted. The application developer companies tend to be small and tend to be precariously financed.

Most mobile location service applications will depend on the quality of their content for their success. Updating dynamic content is likely to be even more challenging; we tolerate incomplete or wrong transport information from the transport companies themselves partly because it is free, and partly because they have a monopoly. Paid for services, and perhaps sponsored services too, are unlikely to enjoy the same level of tolerance.

Independent and operator-owned wireless portals are primarily concerned with making the user's experience of their sites as personal as possible. The ability of location to add context and relevance to generic content is therefore seen as very important. Moreover, allowing the user to filter content by location increases the probability that the user will further respond to retrieved information, either by requesting further information or by initiating a transaction. This has the effect of extending the session, and thereby making the portal site more attractive.

Systems integrators can benefit from network-based location services because it allows them to expand the portfolio of services that they can offer to clients. Until now though, the benefits have more or less been restricted to companies that were prepared to at least manage and perhaps also develop in-house operations systems. Location capability embedded into public mobile networks, open application programming interfaces available to developers, and the possibilities of web-based user interfaces turn this on its head.

Location service is a powerful new channel for advertisers and the merchants for whom they provide service. Mobile Internet advertising is not yet even in its infancy, and there are many issues to be addressed before it becomes a significant destination for advertising revenues.

Some application developers (but not as many network operators and advertisers) have been enthusiastic about location-based 'push' advertising. Others have suggested 'permission' or 'pull' advertising as the way forward. Still others are focusing on sponsorship of free location-based information services, or premium placement within such services.

Location services offer retailers the potential to harness the power of new media to regain some of the ground threatened by Internet-only retailers. 'Bricks and mortar' merchants necessarily enjoy some advantage over their Internet competitors. Internet purchases always involve a latency period between purchase and gratification. There is a reduced opportunity to sell product complements, or for serendipitous purchase on the Internet. Location-based advertising, or sponsorship of content with information services allows merchants with a significant footprint to gain some leverage from this.

Regulation in Western Europe and Privacy requirements

Technology push and regulation are driving the market development for location based services, there is no not pull from the user. Regulatory requirements are driving, but also holding back the market. The uncertainty surrounding the regulations environment is acting as a barrier to deployment of location technology by operators. The main concerns about regulations are "privacy requirements" and "third party access to location data. Regulators in the US, Europe and elsewhere have not indicated that there will be any moves to force mobile operators to open up their location databases so as to enable third-party portals and content-providers to offer location-based services. Regulators have also moved to protect the privacy and security of location data taking the view that information about a mobile user's location is the property of the user, not the operator – with important implications for future mobile location service revenue models.

The European Commission (EC) has drafted its approach to privacy and data protection in respect of location technology. A working paper, issued in April 2000, will replace the existing EC Directive on data protection in the telecommunication sector. It argues that the ability of processing very precise should not induce to a situation where mobile phone users are under permanent observation. The document suggests that the location data should processed anonymously or with the agreement of the user. There should also be a very simple mechanism to allow location information to be withheld on a temporary basis even where general consent has been given.

In some quarters hopes has raised that the EC, or national regulators, might favour compelling mobile operators to allow third-party service developers and content providers access to users` location data. These hopes are unlikely to be met. The EC sees no reason to become involved in this potential dispute, because commercial negotiations should be sufficient to resolve it.

Emergency call services

1-1-2 is the single emergency telephone number for the European Union. It was established by Council Decision of 29 July 1991 and reinforced through subsequently adopted legislation namely the Directive 98/10/EC of the European Parliament and of the Council of 26 February 1998 on the application of open network provision (ONP) to voice telephony and on universal service for telecommunications in a competitive environment (Article 7.2, Official Journal L 101, 01/04/1998 p. 0024 - 0047).

Requirements for location accuracy and latency are very depending on the environment (rural, urban) and on the situation (ability of the caller to provide information, visibility) and are summarised in the table 2 [8].

The associated accuracy requirements are approximately 150 m in urban environment and 500 m in suburban and rural environments. Emergency services requirements related to accuracy are not limited to horizontal accuracy but also concern vertical accuracy. Vertical accuracy requirements for "Mobile Caller finding" are approximately 10 - 15 m (thus enabling to make the distinction between 3-4 floors in a multi-store building.

The caller's position mentioned above must be available within 30 seconds of call initiation. In addition to this accurate positioning information, emergency services

indicate that it can be useful for an emergency centre to receive as quickly as possible a first rough estimate of the caller's location (and to receive later the accurate positioning information mentioned above).

Table 2. The requirements of accuracy and latency [8]

Area	Caller can provide general information	Caller cannot provide any information
Indoor	10 - 50 m	10 - 50 m
Urban	10 - 50 m (25 - 150 m)	10 - 50 m (10 - 150 m)
Suburban	30 - 100 m (50 - 500 m)	10 - 100 m (10 - 500 m)
Rural	50 - 100 m (100 - 500 m)	10 - 100 m (10 - 500 m)
Highway Crossroads	20 - 100 m (100 - 500 m)	10 - 100 m (10 - 500 m)
The caller's position must be available within 30 seconds of call initiation.		

Emergency services also indicate that the availability of location information could be used not only to determine the caller's location but to recognise that several calls are for the same incident too ("Call cluster").

Consequently, emergency services want to be provided not only with a mobile position estimate (X,Y co-ordinates) but also with an indication of the reliability associated to this position estimate. Typically, the level of reliability could be indicated through the provision of a geographical area (e.g. a circle centered on the position estimate and with a radius equal to the required accuracy) and of a probability that the real position effectively belongs to the geographical area. Although the information provided by the Member States through the questionnaire does not specify clearly the expected reliability level, it shows that 67% can be considered as the minimum acceptable reliability level associated to the accuracy requirements mentioned in the table above.

112 databases and sources of location information need to be available 24 hours, every day and kept accurate in line with common digital maps/databases in use in the geo-political area. A map reference must be given in a format that when passed-on and used on another location display system, it actually will give the right physical position in a street/rural area.

Cell-ID and its variants are the only technologies able to operate over 100% of the area covered by a network. E-OTD works within environments where three or more BTS are visible and degrades to Cell-ID where only one BTS is visible. A-GPS performance in certain indoor environments could be problematic. However, there are techniques available to increase the sensitivity of A-GPS receivers and hence improve the probability of a location fix, as well as the resulting accuracy indoors.

Concerning the requirement related to a first rough estimate of the caller's location (200 – 300 m accuracy, available within 7 seconds):

- Cell-ID and its variant can meet the requirement only in dense urban environment;
- E-OTD can meet the requirements in all environments, except in the rural areas where the network may not provide sufficient cells to enable triangulation;
- A-GPS can fulfill the accuracy requirement in all the environments (indoor environments are problematic, but implementations exist that could achieve the "7 seconds" requirement);
- OTDOA will produce accuracies equivalent to Cell Identity when the target is near the base station.

Considering all these aspects and assuming that all the other conditions are fulfilled it is estimated that Cell-ID in Lithuania is widely available by now days, but Cell-ID enhanced with Timing Advance and optionally with signal strength measurements (E-CGI) is not available. E-OTD and A-GPS would probably not be implemented before 2005 - 2008. The implementation of Cell-ID, OTDOA and A-GPS in UMTS networks would be obviously conditioned by the deployment of the network themselves.

The cost for implementing the A-GPS solution vary from 10 – 100 M Euros, depending on the size of the country and the number of base stations in a network that would need to be equipped with timing reference stations (3200 Euros per BTS). The increment of terminal cost would be small (from less than 1 Euro up to 25 Euro). Penetration estimates largely vary. Some believe that they could reach a level of 75 – 100 % by the end of 2006 whilst others are more cautious estimating that the penetration rate of new terminals will follow a natural rhythm to range between 5 and 10 % per year. General agreement exists that E-OTD will only be deployed in areas where commercial applications are of value, i.e. in urban areas. Operators were remarkably consistent in their assessment that only 50 % of their GSM network would reasonably be covered by E-OTD.

To pay for true Enhanced 1-1-2 and all of its inherent benefits, each subscriber should pay 1 to 2 Euros a month. This is the cost model that is widely deployed in the USA for 911 operation. This finance mechanism would allow governments to employ more emergency personnel, vehicles and other needed equipment.

Intelligent Transport Systems (ITS)

Intelligent Transport Systems (ITS) are generically defined as the integrated application of advanced technologies, such as computing and communication technologies, to improve the transport system by making it more efficient, safer and sustainable in terms of technology, society and the environment. In the aimed situation, different systems are incorporated together in order to maximise the benefit of ITS. There exist some comprehensive system architectures in the world that aim to describe the high-level connections between different system components. In the context of personal navigation services most interesting services are associated with the planning of multimodal travel chains before the journey as well as supporting travelling during the journey.

The most significant ITS Architectures are developed both in the U.S. and in the European Union. The first version of the U.S. Architecture finished 1998 [9] and of the European Architecture 2000 [10]. The main emphasis

of the U.S. Architecture is on Physical Architecture and so-called Market Packages. There are twenty one subsystems in the physical architecture distributed among four classes: Traveller, Center, Roadside, and Vehicle. The specific choice of twenty one subsystems represents a lower level of partitioning of functions that is intended to capture all anticipated subsystem boundaries for the present, and 20 years into the future.

The European ITS Framework Architecture is concentrated on Functional Viewpoint and defines the underlying vision as being "the minimum stable framework necessary for the deployment of working and workable ITS within the European Union until 2010"[10]. The European ITS Framework Architecture stays on a level of abstraction that is high enough to avoid constraints on any design and implementation plans, which will have to be developed by each country, region or manufacturer using the Framework Architecture. It provides a Reference Framework, a Common Terminology and a Set of Recommendations.

Commercial Assistance Services

Most people buy wireless phones primarily for safety and particularly for car problems and medical emergencies. These two fields are the major market drivers, which push service providers to invest in providing users with adequate solutions.

The most relevant class of Commercial Assistance Services based on wireless location systems is represented by Driver Assistance services. The attention has been focused on breakdown assistance, car accident detection and rescue and car theft recovery. All major service providers have chosen GPS/DGPS technology for positioning and wireless network for communication. This kind of service has been working on the market successfully for several years.

Further developing application consists in remote diagnosis service, if a problem is due to a fault, the vehicle sends also selected data obtained by monitoring the on board systems, so as to allow a remote diagnosis and the most appropriate intervention.

According studies carried out by the U.S. Department of Transportation by the year 2005 the annual number of crash deaths will raise to 51.000 people killed per year. Historically in motor vehicle crashes more than 3 million Americans have been killed and 300 million injured.

The European situation is also worse taking into account the greatest number of circulating vehicles. The annual number of crash deaths is about 40.000 people.

Automatic accident detection is another important service. It allows vehicle equipped with crash sensors, air-bag deployment detectors to automatic raise an accident alarm towards the service centre whenever these events occur, without any action by the driver that could have fainted. The service control centre is able to precisely locate the vehicle and dispatches an ambulance, tow truck, or other appropriate emergency response services to the accident.

The personal assistance market is a new and emerging commercial sector with massive potential. There are several "weak " people categories that in particular situation can need assistance. People suffering of particular pathologies, risk groups, elderly have high probability to need medical assistance. The immediate knowledge of the clinical situation, past clinical history, blood group and so on, retrieved from a personal database managed by a Service Provider can save a lot of time necessary to perform generic clinical examinations and potentially save lives. When a medical emergency occurs the majority of elderly people can fall in distress condition and they are not able to communicate precisely their location and describe properly the actual situation.

Service Providers can offer customised assistance services for different classes of users. They can also provide their subscribers with medical aid sending to the exact location of the intervention a private ambulance with physicians experts in the particular disease affecting the user or routing all the information to the public authorities. People belonging to determined risk groups can combine medical sensors monitoring some vital functions with automatic emergency request to the dedicated call centre in case of detected anomalies or devices malfunctions (e.g. peacemakers). The message automatically dispatched to the service centre contains both positioning data and information relevant to the patient status, potentially useful to perform early remote diagnosis. Insurance companies can grant some sort of discount to people subscribing these services.

Another important market sector is represented by the personal security. This kind of services is oriented to people such as women, children, elderly that more likely can be victims of aggressions, rape, robbery, kidnapping. In case of aggression people subscribing personal protection services can simply pushing a concealed button on their handset send an immediate help request to the call centre, comprising positioning data.

Personal protection services are also requested by other groups such as lone workers generally acting far from their home base. Special services are customised by service providers to support the demands of this kind of users.

People requiring personal services need to be localised in a very short time, and this could be difficult in several environments such as urban environments, inside of the buildings, moreover a trade off between the accuracy precision and the fast fix of the position has to be achieved taking into account the available technologies.

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V. Liutkauskas, D. Matulis, R. Plėštys. Vietos nustatymu pagrįstos paslaugos // Elektronika ir elektrotechnika. - Kaunas: Technologija, 2004. – Nr. 3(52). – P. 35-40.

Pateikiami vietos nustatymu pagrįstų paslaugų teikimo GSM tinklu technologiniai ir juridiniai aspektai. Atliekant technologinių aspektų analizę, turi dalyvauti tiek mobiliųjų tinklų operatoriai, tiek technologijų ir paslaugų turinio kūrėjai. Mobiliųjų tinklų technologinės galimybės jau šiandien įgalina pradėti teikti vartotojams šį paslaugų paketą. Pagrindinė tokių paslaugų kūrimo kliūtis yra organizaciniai ir asmens duomenų privatumo užtikrinimo reikalavimai. Šie reikalavimai palaipsniui įgyvendinami sudarant komercinius susitarimus tarp paslaugų teikėjų ir paslaugų vartotojų. Viena iš neatidėliotinų paketo paslaugų yra skubi pagalba asmenims, nukentėjusiems avarijose, užpuolimų atvejais ir esant sveikatos sutrikimams. Nusistovėjusi nuomonė, kad pagalbos prašančio abonento vietą pakanka nustatyti su 150-500 m paklaida per 30 s, o toliau ją tikslinti vykstant į įvykio vietą. Aptartas lokacijos paslaugų, susijusių su žmonių saugumu ir sveikatos sutrikimais, taikymas kuriant intelektualias komercines transporto sistemas. Il.1, bibl.10 (anglų kalba; santraukos lietuvių, anglų ir rusų k.).

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В. Люткаускас, Д. Матулис, Р.Плештис. Услуги на основе определения место положения абонентов // Электроника и электротехника.-Каунас: Технология, 2004. – № 3(52). – С. 35-40.

Представлены технологические и юридические аспекты услуг, основанных на определении местоположения абонентов. При рассмотрении технологических аспектов должно учитываться заинтересованность операторов, возможности создателей технологий и содержания услуг. Настоящие возможности сотовых сетей связи позволяют уже сейчас предложить пакет таких услуг. Однако основным препятствием предоставления услуг является организационные вопросы и защита персональности данных. Они решаются путем подписания комерческих контрактов между предложителями услуг и пользователями. Одним из неотложных пакетов услуг этого класса является срочная помощь пострадавших в автоавариях, в случаях нападений и при внезапных приступах. Общепринято, что допустимая погрешность локализации абонента в этих случаях составляет 150-500 метров в зависимости от того, в городе или в сельской местности находится абонент. Время установления местонахождения абонента не должно превысить 30 сек. при условии, что после этого можно уточнить это место. Претставлены варианты использования услуг локализации в транспортных системах, а также для создания других пакетов услуг. Ил. 1, библ. 10 (на английском языке; рефераты на литовском, английском и русском яз.).

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