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If you can't measure it, you can't manage it: a beginners guide to location-based services

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Introduction

LBS or Location Based Services is yet another three letter acronym that has taken the GI industry by storm. In the same way that the launch of the Internet brought about a plethora of 'web-enabled' GI applications, so the increase in remote working and use of mobile communications has sparked a variety of Location Based Service (LBS) offerings. But whilst these developments in LBS have taken advanced GI professionals into a bright new world, it has left the rest of us wondering what it all means.

LBS in its simplest form can be described as the ability to send up-to-date information to a mobile resource based on its current position. An example would be, sending live traffic reports; specific to the area a vehicle is currently operating in, as a text message to a mobile phone. Whilst location technologies, such as GPS (Global Positioning System) and mobile communications have been available for a number of years now, it has only been recently, due to new location techniques and improvements in mobile communications, that LBS has been commercially viable. This recent trend points towards a massive growth in LBS; indeed estimates for predicted LBS based revenue by 2005 range from $11 billion world-wide (VanderMeer, 2001) to $33 billion for Europe alone (Smith, 2001).

This paper is intended to serve as a beginner's guide to LBS, individually examining the various elements of a complete solution (see Figure 1), including Location Techniques, Hardware, Networks and Software and offering advice on the issues one should consider when looking to implement an LBS solution. Understanding how the various elements of LBS fit together, the pros and cons of each and the current system requirements are key to selecting the right service.

Location Techniques

As the term Location Based Services suggests, the ability to fix the current position of a resource, be it a phone, a person or a vehicle, is vital to the currency and usefulness of the entire LBS. Many existing LBS applications, particularly those delivered via mobile phones and Palm-top technology, require the LBS user to either select their location from a pick list, or even to type it in. As the example below suggests, this is hardly an ideal scenario.

'A simple example: I was standing outside New York City's Jacob Javits convention center, wondering where to eat lunch. Using the Palm-Minstrel combination, I called up CitySearch.com for restaurant reviews. But to find a local restaurant, I had to enter a zip code. Now, how would I know the zip code unless I already knew the area I was in? It's not like zip codes are posted on street signs. Obviously, the designers of CitySearch have never been stuck on a Manhattan street corner with nothing but a wireless device.' (Tweeny, 2000)

Whilst typing in the current location may be undesirable for public LBS applications, it is totally impractical for Business solutions; a means of automatically detecting the resource location is a necessity. As the available technology has progressed, so has the variety of Location Determining Technologies (LDT) and understanding the differences between these is imperative when deciding upon the most suitable technique to adopt.

Global Positioning System (GPS) is the system by which a resource can locate itself using a series of 24 US satellites currently orbiting the Earth. Historically, GPS was inaccurate due to a system know as Selective Availability that deliberately degraded the signal for non-military use. However, following an announcement by Bill Clinton on 1 May 2000, the error in GPS known as Selective Availability has been removed, making GPS up to ten times more accurate, with the ability to fix a position to within 20 metres.

The benefits of GPS are that, subject to purchasing a receiver, it will work anywhere in the world and (most importantly) is free of charge. However, due to the way in which the location is calculated, there are many potential sources of error. A typical example of this might be canyoning (whereby a GPS signal is reflected off objects such as tall buildings before it reaches the receiver); this has been particularly problematic in city based LBS applications. Another limitation of using GPS is that a receiver must be able to 'see' the satellites in order to fix its position and will therefore not work under a bridge or inside a building, since unlike GSM telephones, the signal cannot penetrate a building.

More recently, location-determining technologies based on mobile phones have been developed, such as Cell ID or E-OTD (Enhanced Observed Time Differential). In the most basic form, this technology enables the position of a mobile phone to be fixed to the network cell it is currently operating within (depending on the density of phone masts, this may be anywhere from a few hundred metres to a few miles off target). Recent developments, such as the E-OTD method adopted by Cambridge based CPS, have enabled more accurate positioning by measuring the distance from the nearest three phone masts to calculate a more accurate position within that network cell. (see Figure 2).

Whilst such technology offers accurate position fixes to within 50 metres of the target without the requirement for separate GPS equipment, in order to be available nationwide, this system may require alterations to both the telecoms network and the mobile handsets.

Hardware

The hardware requirements of a LBS application will depend on numerous factors, including the network, the adopted Location Determining Technology and the functionality required at the remote site.

In a typical LBS scenario, devices are required to obtain a location fix and to then send the positional coordinates of that fix along with status messages and any other data from the mobile resource to a base station. These devices will vary in style and complexity; in a simple application, such as tracking a vehicle, a GPS and a simple two-way radio may be all that is required. In a more complex situation, for example where a map and directions are to be forwarded to the mobile resource, more advanced hardware such as a GPS coupled with a palm computer may be necessary. This ability to match the hardware to the intended use, may be one of the reasons that LBS has not spread as rapidly as first predicted, as the mobile hardware is often not suitable for purpose.

'For Internet-enabled 'phones, the actual viewing area for content is limited to approximately 16 characters wide by six lines of text high. This is not much space for viewing e-mail, driving directions, movie reviews or stock quotes. As the physical size of phones continues to shrink, this visual challenge is going to get worse. As a result, consumer acceptance of the wireless Internet has not taken off.' (VanderMeer, 2001)

Whilst separate location determining and communication devices will provide a somewhat cumbersome LBS solution, new technological developments are creating integrated handsets that provide both functions. For example Benefon, a Swedish mobile handset manufacturer has launched a mobile phone with built-in GPS - the phone also features a panic button for Lone Worker Protection applications.

The development of alternatives handsets will provide a better choice of hardware for the consumer allowing, the most suitable equipment for each LBS application to be selected.

Networks

In order to send positional information and any other information between two locations, an LBS solution requires a mobile communications network to carry the messages. As with other elements of LBS, the choice of which network to use depends upon numerous factors, most especially the level of functionality required.

There is a wide range of network providers offering anything from voice only communication to high-speed data and voice services. It is therefore necessary to decide upon the level of functionality required, hence the demands that will be put on any network. A primary consideration must be the type of communications required, Data, Voice or Voice and Data network. Data only networks, for example, will allow positions, status and text messages to be sent fast between the base and the remote, but will not facilitate voice calls.

Networks are also available at a range of scales, from private mobile radio networks (specific to a single company) through business network providers (available to commercial users only) to the large GSM network providers (available to anyone). Again, the selection of the correct (or most suitable) network is an imperative part of the LBS solution. It is worth considering the implications of choosing the wrong network; a panic alarm sent by SMS (text messaging) may take up to 24 hours to reach its target, by which time it may well be too late.

Different networks offer alternative pricing structures too, based on either volume of data transmitted, number of messages sent or time connected to the network. It is therefore crucial that all the above issues are evaluated when deciding upon the network to use, as choosing the wrong network will affect the efficiency, functionality and cost of the entire system.

Software

The software element of LBS may be separated into two sections; the software at the remote end of the system and that at the base unit. Software is rarely required at the remote end of the system, as the required analysis (e.g. finding the nearest facility) is usually conducted at the base unit and the result sent back. Where more functionality is required by the mobile resource, then software may be necessary, but generally this will be similar in style to that at the base unit.

In order for a computer system to interact with a mobile communications network, the first piece of software required is a port-driver. The port driver enables messages sent across a network to be read by a PC and vice versa; different port drivers will exist for each of the available networks. The port driver software takes messages arriving from the mobile network and cuts them into their component parts, such as time sent, mobile resource ID, position fix and any message. Where these elements are then stored will vary from system to system, but generally they should be stored in an open database so that any further software can make use of the data.

These elements, stored within a database are then used within the tracking application, which will update the position and status of resources on the map based on the latest information received through the port driver. As the tracking application reads information from the same database that the port driver software is updating, then the information portrayed within the system will be as current as the last message received. Based on this information, the software can then carry out whatever function is required, such as returning the name of the nearest restaurant or producing the route home.

As LBS develops further, the level of functionality available at the base unit will need to increase, as will the relevance of the information to the particular user requesting that service. As increasing demands are placed on the LBS to deliver more information, core GIS based solutions will start to have an advantage over other LBS solutions, as the ability to carry out routing and other analysis has already been successfully developed on the desktop products. This increased level of services and personal relevance will hopefully entice more users into the realm of LBS.

‘The wireless Internet is an extension of the online world we know today but, when you move away from the PC, you need a lot more personal information. As the richness of devices decreases, the richness of services becomes more important.’ (Moore, 2001)

Other measurable inputs

Depending upon the application to which LBS is being adapted; extra devices may be included into the LBS system to provide information on other variables relevant to the particular application, such as the updating of road data based on current traffic reports. This adds to and improves functionality to the system, for

example a lorry may be fitted with a fuel sensor so that when the fuel level drops sufficiently the driver is notified of the nearest filling stations to replenish his tank.

These various devices may be added onto the system as a separate bolt-on. The values from these devices will then feed further data into the radio or phone before transmission, so that when the port driver software picks up the resource's position, it also identifies any other information, such as its weight and temperature. Whether an LBS solution can accept inputs from other devices should be established at purchase, as current requirements may alter over time and it is imperative that the solution also has the ability to adapt easily, without considerable financial outlay. Again this is where LBS solutions using an existing GIS will set themselves apart from the others, as the required functionality to input various sets of data has already been developed.

A Role for Geographic Information Systems

GIS is basically the application for the expression of the science of spatial relationships and as such has an important role to play in LBS. True topological GIS has the ability to store, manipulate and report on the spatial associations between various objects on the ground. They can be easily adapted to monitor the locations of mobile devices and consequently their spatial association to fixed objects. GIS is therefore ideally placed to compute closest facilities to a mobile device, for example "where is my nearest petrol station, etc." Given also that they are capable of analysing historic spatial information, they are ideally suited to plotting paths from roaming mobile devices. Routing applications form part of the GIS toolbox and again are optimum for calculating route-based answers to spatial problems. Examples of this are to be found in Operation Mapping Systems (OMS) where the system can quickly calculate the shortest driven route from an incident to the closest "x" number of moving resources capable of dealing with the incident.

There are a number of GIS products on the market specifically targeted at the time and location constrained object analysis market place including ESRI's Tracking Analyst, which can form the core of a specifically tailored solution. This also raises the point of making the base application focused and targeted towards the end user requirements, but maintaining the functionality of the core generic software with all the benefits that this can deliver.

Implications on current working practices

From past experience, introducing LBS technology to an organisation results in a mixed reception. Whilst the benefits to management of being able to closely monitor the exact status and location of company resources are clear to see, the reactions to 'Big Brother' technology are often underestimated.

"For a company considering rolling out wireless applications to consumers or workers, having the ability to track the whereabouts of customers or employees will require a higher level of corporate readiness", Passmore said. Further, "Companies need to realise they will be scrutinised by all sorts of groups, and it will become a big issue," (Hamblen, 2000)

As LBS technology moves forward and begins to incorporate the tracking of mobile telephone handsets, the pressure on companies to improve and control security will increase dramatically.

"[Wireless products] could be designed in such a way that a cell phone becomes a tracking device not controlled by the user, which could be used by private companies or the government to collect very precise information about the daily movements of a person without their knowledge, without their control." (Dempsey, 2000)

Conclusion

When looking to adopt an LBS solution, it is necessary to evaluate all the elements of the solution to decide which options are most suitable for the required application but are also cost effective. The increasing variety of hardware, software and network providers will enable increased choice to the LBS consumer and (hopefully) a drop in the cost of implementing a solution, cooperation between all players in the field will be required to build integrated solutions.

It is apparent that basing any application upon proven generic technology, from the mobile device right through to the end user application will deliver the maximum level of benefit with the minimum level of exposure to risk.

It is clear that the ability to monitor the real time location of all resources and to communicate with them enables much improved control over company assets and operational efficiency even when subjected to rights-of-the-individual legislation, but the ability of the benefits outweigh the costs still remains to be proven in a wider context and at a large scale.

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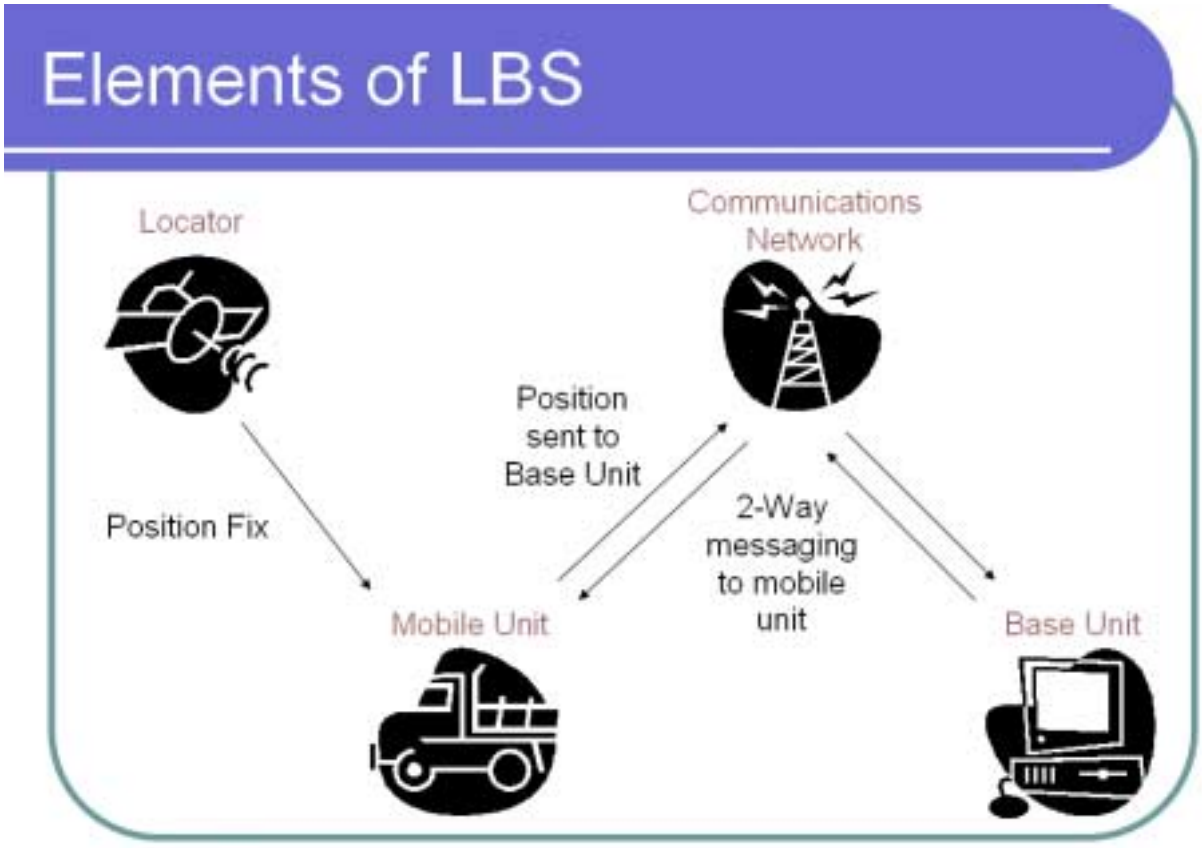

Figure 1 – Elements of a Location Based Service

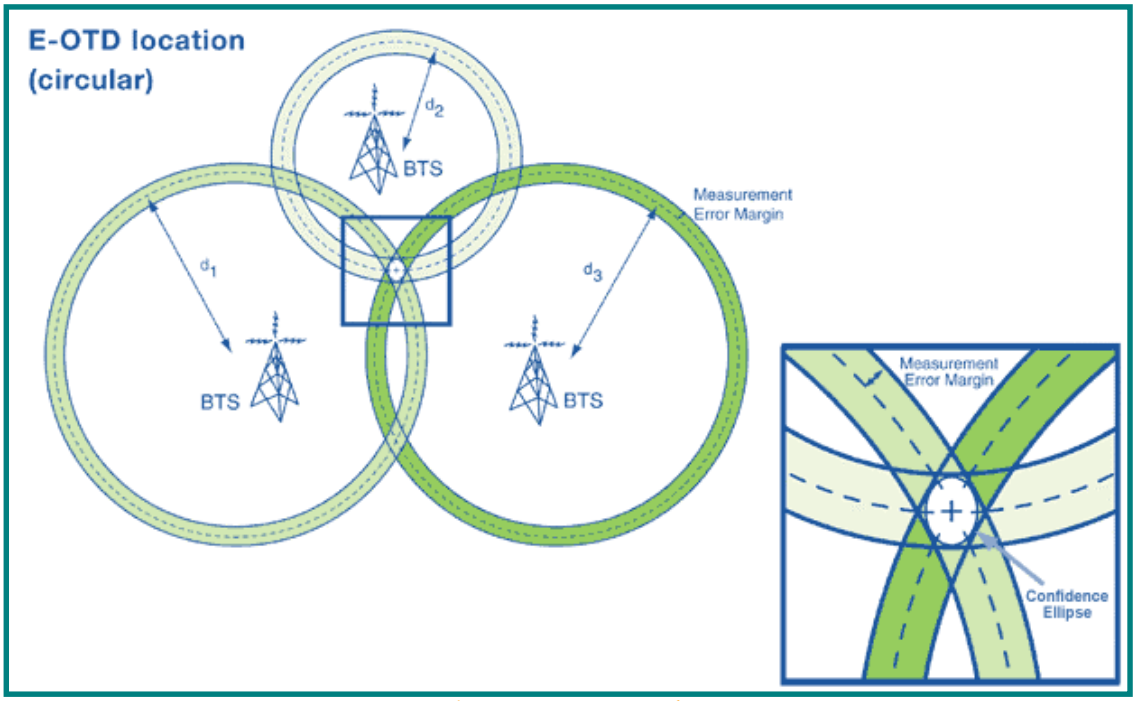

Figure 2 - How E-OTD works

CPS (Diagram may be found at http://www.cursor-system.com/sitefiles/cursor/tech_eotd.htm)