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Location Based Services on Mobile E-Commerce

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***Abstract*— Mobile e-commerce (m-commerce) is defined as all activities related to a commercial transaction conducted through communications networks that interface with wireless (or mobile) devices. It is started recently to appear in the scene by exploiting the advantages of internet, mobile computing and mobile communications in order to provide a large number of advanced services to mobile users. In this paper we concentrate on special case of M-commerce are Location Based Services (LBS) where often the actual position of the terminal is used in the service provision. A Location-Based Service (LBS) is a mobile computing application that provides information and functionality to users based on their geographical location. As technology is an important facilitator and at the same time a limiting factor, we review the technology aspects relevant for LBS.**

***Keywords*— Mobile E-Commerce, Wireless Networks, Location Based Services, Geographical Information System.**

I. INTRODUCTION

Wireless communication technologies combined with Internet-enabled terminals constitute an ideal platform for the realization of much new kind of business transactions. The small and light, but powerful, mobile terminals are almost always carried by their owners. The number of mobile customers that use digital mobile networks for voice and data transfer. Therefore, they are like a wallet, among other things. They can indeed also store electronic cash, credit card information, tickets, etc., and can thus also take the role of an electronic wallet. In addition, the terminals can be located by using satellite navigation systems, within mobile networks, or by some other available means. Recent developments in these areas seamlessly extend the positioning of wireless devices into all the environments where they can be used for voice and data communication. Thus, location-based services become possible.

The technological infrastructure consists of mobile networks, mobile terminals and positioning technologies. Requirements considered for the LBS domain refer to all the involved actors i.e., the mobile users, the telecom operators, the service providers, the content providers, etc. In this paper we concentrate on special case of M-commerce are Location Based Services (LBS) where often the actual position of the terminal is used in the service provision, as the related M-Commerce is probably the best example of the new emerging applications.

II. COMMUNICATION INFRASTRUCTURE

In this section we briefly describe the technology used for mobile terminals and Mobile E-Commerce.

A. Development of Mobile Networks

Currently, the three basic second-generation (2G) digital wireless telephone technologies are:

- Time Division Multiple Access (TDMA),
- Global System for Mobile (GSM), and
- Code Division Multiple Access (CDMA).

All these technologies are circuit-switched services. A user must dial in and maintain a connection to obtain data communications. GSM is the most widely used of the three technologies, especially in Europe, but the current speed of GSM is only 9.6 kilobits per second (Kbps). From M-Commerce point of view, Circuit Switched Data (CSD), High Speed Circuit Switched Data (HSCSD), Global Packet Radio Service (GPRS), and Short Message Service (SMS) are important in the GSM standards.

In the current 2G networks the capacity ranges from 9.6 kbps to 14.4 kbps on CSD connections. The standardization for the third generation of mobile telecom systems (3G) was started at the beginning 1990's. Universal Mobile Telecommunications System (UMTS) is the European view on the 3G systems envisioned in IMT-2000. The UMTS standard family was developed by 3G Partnership Project [1] hosted by the European Telecommunications Standard Institute (ETSI).It offers broadband, packet-based transmission of text, voice, video, and multimedia at data rates that will reach 2 Mbps and greater. Based on GSM, UMTS is the planned global standard for mobile users. Once UMTS is fully implemented, computer and phone users can be attached continuously to the Internet and have access to a consistent set of services worldwide. 3G networks will enable speeds up to 2 Mbps depending on radio conditions as well as the network environment (e.g., satellite, indoor, outdoors). In worse circumstances (e.g., weak signal, or in the move) the wireless link capacity will be only a few hundred kbps.

The innovation towards 4G networks has also already begun. They should be in operation around 2012. The hopes for the offerings are: seamless roaming and handoff between various types of technologies such as UMTS/W-CDMA, Bluetooth and Wireless LANs; truly seamless wireless Internet access and more bandwidth for wireless data transmission. The main objective as concerns roaming and handovers is to materialize the Always Best Connected (ABC) idea.

In the basic 2G network the services are voice; circuits switched data (CSD) transfer, and short messages (SMS). Especially short messages have been used to support financial services like banking and stock services. CSD can be used as the carrier in a TCP/IP network and it is possible to do Internet banking e.g., hand-held Communicators over CSD.

At the service level in 2G+ networks the de-facto standard Wireless Application protocol (WAP) [2] provides an access to higher-level services. These include support for E-commerce. WAP technology brings Internet and wireless technologies together so that contents encoded in a mark-up language at WWW servers can be moved to handsets.

Bluetooth is another emerging technology that will evidently have impact on M-Commerce and also on LBS. Using this technology it will be possible to conduct M-Commerce transactions without a heavy network infrastructure. Thus, handheld devices could talk directly e.g. with cash registers. Currently integration of Bluetooth and WAP are under way [2]. Bluetooth can be also used for small LANs, in addition to ad hoc point-to-point links. The maximum rate achieved by Bluetooth1 is 722 kbps, and Blutooth2 2Mbps. Bluetooth advances are that the infrastructure is simple, relatively cheap, and operated in unlicensed frequency bands. From LBS point of view, Bluetooth is able to offer a local positioning method if some of the transceivers is in fixed position and this information can be used by LBS applications.

B. Mobile terminal

Most of the new mobile phones have already support for GPRS, Bluetooth and MMS, inbuilt or attachable camera, as well as sophisticated applications. The smart phones have high-resolution color display (e.g. 176x208 pixels with 4096 colours) and several megabytes of internal memory, which can be supplemented with memory cards. In addition to operating systems, common platforms are becoming prevalent between the devices. For example Nokia's Series 60 mobile platform has already been licensed by majority of the key players within the mobile phone industry. The common platform over the operation systems provides some common applications and they make application development easier and faster, still allowing required differentiation for markets. The mobile devices are becoming location-independent, widely distributed personal trusted devices (PTDs) that strongly support the realization of financial transactions and other activities related to M-Commerce [3]. To address the need for extra security in the mobile environment, the Wireless Application Protocol Public Key Infrastructure WPKI) was specified [4]. The WPKI encompasses the necessary cryptographic technology and a set of security management standards that are widely recognized and accepted for meeting the needs of M-Commerce. It is also worth mentioning the Mobile Electronic Transactions (MeT) forum [5] that refers to the application side of mobile commerce. MeT was established to further strengthen the framework for secure mobile transactions. It concentrates on defining a consistent and coherent framework that is based on existing standards and specification.

III. LOCATION BASED SERVICE

Location based services require specific infrastructure for positioning the mobile terminal. Positioning means determination of the location of the object in a reference system. The reference system can be a coordinate or address system, areal division or route system [6]. The systems offering positioning for mobile terminals in LBS are divided to three main classes [6]: satellite positioning, network-based positioning and, local positioning. Different positioning systems and techniques vary with their features, such as accuracy, reliability and time-to-fix. Each system has its own place, and they complement each other in certain cases. Satellite systems do not work well in deep canyons and indoors where cellular coverage may be denser. Network-based positioning may be more imprecise in rural environments with fewer base stations, where satellite visibility is better. Location Based Applications can be classified as person- Oriented or device-oriented

- Person-oriented applications: Applications where a service is user-based, turning the focus of the applications determining the position of a person or to use the position of a person to enhance a service. Usually, the person located can control the service. Examples of such applications can be social networking, where the objective is to locate friends or family with the consent of the user.

• Device-oriented applications: Applications that are external to the user, that may also focus on the position of a person, but they do not need to. Instead of only a person, an object (e.g., a car) or a group of people (e.g., a fleet) could also be located. In device-oriented applications, the person or object located is usually not controlling the service. Examples for this kind of applications can be car tracking for theft recovery, where the car is sending information without human intervention

A. LBS Communication Model

Technologically, the implementation of LBS can be described by a three-tier communication model, including a positioning layer a middleware layer, and an application layer as illustrated in the Fig.1

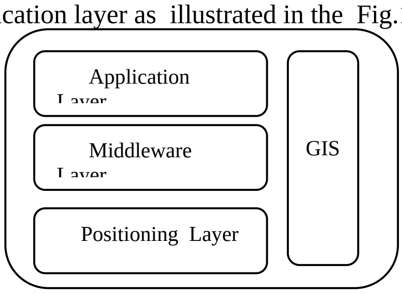

Fig 1. LBS Three-tier Communication Model

• Positioning layer: Responsible for calculating the position of a mobile device or user. It does so with the help of

position determination equipment(PDE) and geospatial data held in a geographic information system (GIS).While the PDE calculates where a device is in network terms, the GIS allows it to translate this raw network information into geographic information (longitudes and latitudes). The end result of this calculation is then passed on via a location gateway either directly to an application or to a middleware platform. Originally, the positioning layer would manage and send location information directly to an application that requests it for service delivery.

- Application layer: Also known simply as client, comprises all of those services that request location data to integrate it into their offering.
- Middleware layer: As the LBS application market grows, many network operators have put this layer between the positioning and application layer, primarily because PDE sits close to the core of a mobile operator's network, leading to complex and lengthy retrieving of each user data service. This layer can significantly reduce the complexity of service integration because it establishes one single connection to the network, and then mitigates and controls all location services added in the future, saving operators and third-party application providers time and cost for application integration [7].

Simplifying application integration is important for mobile operators in order to move to a so-called wholesale model for location data. The wholesale approach means that operators offer a kind of bulk access to the location of devices. To give an example of how could this bulk access to location information be used there's the fleet management services where company's offering such services have to buy the information of the location of cars from mobile operators. The problem with this wholesale model is that privacy issues arise with the offering of location data from operators. Here, location middleware can fulfill another role depending of its usage in downstream or upstream:

- Downstream: Allows users to manage location access rights of third-party applications.
- Upstream: Systematically anonymizes location information revealed. Thus, the location middle ware takes over a similar role as an anonymizing proxy does on the Internet. In this way, many privacy concerns are addressed by an operator. Also, users get direct access to manage their privacy.

IV. SPATIAL DATABASES

In various fields there is a need to manage geometric, geographic, or spatial data, which means data related to space. The space of interest can be, for example, the two-dimensional abstraction of the surface of the earth, or parts of it (geographic space). The term "spatial database system" is associated with a view of a database as containing sets of objects in space rather than images or pictures of a space. It is considered that spatial DBMS provide the underlying database Technology for geographic information systems (GIS)and other applications.

A. GIS - Geographic Information Systems

GIS is known to be a technological field incorporating geographical features with tabular data in order to map, analyse, and assess real-world problems. The key word to this technology is Geography, which means that the data (or some portion of the data) is spatial (data that is in some way referenced to locations on the earth). Coupled with this data is usually tabular data known as attribute data that can be generally defined as additional information about each of the spatial features. An example of this would be schools. The actual location of the schools is the spatial data. Additional data such as the school name, level of education taught, student capacity would make up the attribute data. It is the partnership of these two data types that enables GIS to be such an effective problem solving tool through spatial analysis.

GIS operates on many levels. On the most basic level, GIS is used as computer cartography, i.e. mapping. The real power in GIS is through using spatial and statistical methods to analyse attribute and geographic information. The end result of the analysis can be derivative information, interpolated information or prioritized information [7].

Typically, GIS is integrated by several components:

- Hardware: Equipment needed to support the many activities of GIS, such as data collection and data analysis. The workstation, which runs the GIS software and is the attachment point for ancillary equipment, it's the main component Data collection requires a digitizer for conversion of hard copy data to digital data and a GPS data logger to collect data in the field. With the advent of web-enabled GIS, web servers have also become an important piece of equipment for GIS.
- Software: The GIS application package is essential for creating, editing and analysing spatial and attribute data, therefore this package contain a myriad of GIS functions inherent to it. Extensions or add-ons are software that extends the capabilities of the GIS software package.

Component GIS software is the opposite of application software. Component GIS seeks to build software applications that meet a specific purpose and thus are limited in their spatial analysis capabilities. Utilities are stand-alone programs that perform a specific function. For example, a file format utility that converts from on type of GIS file to another. There is also web GIS software that helps serve data through Internet browsers.

- Data: The heart of any GIS. Data is divided in two primary types that are used in GIS:

a geodatabase is a database that is in some way referenced to locations on the earth and geodatabases are grouped into two different types: vector and raster. Vector data is spatial data represented as points, lines and polygons, and raster data is cell-based data such as aerial imagery and digital elevation models. Together with this data is usually data known as attribute data, generally defined as additional information about each spatial feature housed in tabular format. Documentation of GIS datasets is known as metadata, which contains such information as the coordinate system, when the data was created, when it was last updated, who created it and how to contact them and definitions for any of the code attribute data.

- Trained personnel: Well-trained people knowledgeable in spatial analysis and skilled in using GIS software are essential to the GIS process

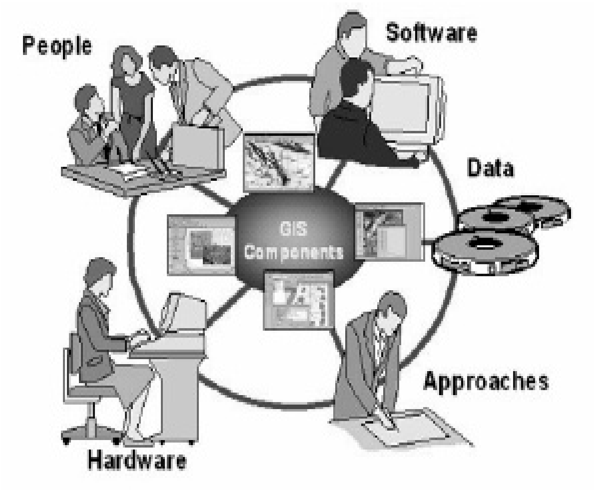

Fig.2 GIS components

V. LOCATION TECHNIQUES

Systems that determine the location of a mobile object can
be divided into two categories [8]:

- Tracking: when a sensor network determines the location.

The object to track has to be equipped with a specific tag or badge that allows the sensor network to acquire its position. The location information is first available in the sensor network. If the mobile object needs its location data, the sensor network has to transfer this information to it by wireless communication.

- Positioning: when a system of transmitters or beacons sends out radio, infrared, or ultrasound signals. The location is directly available at the mobile system and does not have to be transferred wirelessly. In addition, location information is not readable for other users, thus the positioning system does not have to consider privacy issues.

Systems that use tracking as well as positioning are based on the following various basic techniques, often used in combination

- Cell of Origin (COO): Technique used if the positioning system has a cellular structure. Wireless transmitting technologies have a restricted range (i.e., a radiated signal is available only in a certain area around the cell). If the cell has a certain identification, it can be used to determine a location.
- Time of Arrival (TOA), Time Difference of Arrival
(TDOA): Electromagnetic signals move at a very high
speed (light speed - approximately 300,000 km/s), the corresponding runtimes are very short. If a nearly constant light speed is assumed, the time difference between sending and receiving a signal to compute the spatial distance of transmitter and receiver can be used. A similar principle can be used with ultrasound. The signals take a longer time, thus measurement is simpler, but ultrasound can only reach low distances. If the time difference between two signals is measured, the term TDOA is used. In GSM networks, the term Enhanced Observed Time Difference (E-OTD) is often used instead of TDOA.
- Angle of Arrival (AOA): Using antennas with direction characteristics, the direction of arrival of a certain signal can be found. Given two or more directions from fixed positions to the same object, the location of the object can be computed. Because it is too difficult to constantly turn an antenna for measuring, receivers use a set of antennas that are lined up with a certain angle difference in all directions.
- Measuring the signal strength: The intensity of electromagnetic signals decreases even in vacuum with the square of the distance from their source. Given a specific signal strength, the distance to the sender can be computed. Unfortunately, obstacles such as walls or trees additionally reduce the signal strength, thus this method is inaccurate.
- Processing video data: Using video cameras, significant patterns in a video data stream can be acquired to determine the user's location. If users wear badges with conspicuous labels, they can be detected in video images. For this, positioning systems use techniques from image processing to detect and interpret image data. In principle, video positioning systems are based on the AOA technique: a specific pixel in an image represents a certain angle relative to the camera's optical axis; however, video data can transport color information, which can be used to transfer additional information (e.g., the user's identification).

VI. CONCLUSION

LBS are surely an area of modern mobile services where considerable growth is observed. The availability of new network technologies including 2.5G and 3G technologies increased the use of data services. The 'always-on' data connection, the higher data transfer rates, and the charging per volume and per user-value, will enable LBS to benefit from these technologies. The ability to push data to users based on their location and preferences, in a seamless and inexpensive manner, is likely to help LBS services to proliferate. Future releases of 2.5G and 3G technologies are likely to benefit from the fruits of the ongoing effort to standardize different aspects of LBS.

As for the standardization of LBS [9], a big effort is being made, both on the network and application side. Main forces are the3G Partnership Program (3GPP), defining mainly the addition of LBS capabilities to future releases of 3G networks, and the Location Interoperability Forum (LIF), formed by vendors and interested parties to developing and promote common and ubiquitous solutions for LBS which are network and location technology independent. The result of these efforts will have a significant effect on the success of LBS, affecting the technology choice operators will make, the required investment to launch or upgrade existing LBS, as well as on the actual availability, usability, and cost of services.

Our analysis, as presented in this paper, shows that the technologies and issues involved in LBS deployment and provision cover a very wide spectrum including operating system capabilities, user interface design, positioning techniques, terminal technologies, network capabilities, etc.

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