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Mobile communications and mobile services

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Abstract: As wireless technologies evolve, the coming mobile revolution will bring dramatic and fundamental changes to the world. This revolution has already begun and is gaining momentum. The revolution will impact numerous facets of our daily lives and the way business is conducted. It will provide important data in real time to assist decision makers, exert great influence on communications between businesses and their customers, and transform the way we live our lives. This paper examines issues in providing services via wireless technologies, i.e. mobile services. The paper discusses the challenges facing mobile services, such as changes in business strategies, investment risk, limitations in mobile devices, networking problems, infrastructure constraints, security concerns, and user distrust in mobile applications. Research issues, such as killer applications, usability, user interfaces, mobile access to databases, and agent technologies, are also discussed.

Keywords: Wireless technology; mobile applications; mobile services; mobile communications.

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1 Introduction

Advances in wireless technology and mobile devices give rise to a new kind of e-commerce – mobile commerce. Mobile commerce transactions are conducted via mobile devices using wireless telecommunication networks and other wired e-commerce technologies. Mobile commerce (also increasingly known as m-commerce or mobile e-commerce) enables wireless information exchanges and business transactions. Mobile commerce means different things to different people. To customers, it represents convenience, whilst merchants associate it with a huge earning potential; and service providers view it as a large unexplored market.

In this paper, we look at mobile communication technologies and mobile services. Mobile commerce extends current internet sales channels into more immediate and personalised mobile environments. It also gives users the ability to access the internet from any location at any time, the capability to pinpoint an individual mobile terminal user's location, and the functionality to access information at the point of need [1]. In this sense, mobile commerce has the potential to meet the needs of customers and businesses that are not met in traditional e-commerce and to deliver better services with greater flexibility and efficiency. Mobile services present tremendous opportunities to provide value added services to customers and businesses.

This paper is organised as follows:

- Section 2 gives an overview of mobile services
- Section 3 investigates the organisational and technological challenges in providing mobile services
- Section 4 highlights the research issues in mobile services
- Section 5 concludes the discussion.

2 Mobile services

Wireless and mobile networking have presented an entirely new way for companies to better serve their customers. Mobile services will enable users to make purchases, request services, access news and information, and pay bills, using mobile communication devices such as PDAs, laptops, and cellular phones. Another mobile service area that has much potential is the mobile government. Mobile devices can enhance the e-government concept by allowing constituents to access government services through mobile devices. This section focuses on mobile commerce, highlighting the key features of mobile services, describing the communication technologies and discussing the different types of mobile services.

2.1 Features of mobile services

The essence of mobile services revolves around the idea of reaching customers and partners regardless of their location. It is about delivering the right information to the right place at the right time. This flexibility of mobile services is made possible by the

convergence of the internet and wireless technologies. Some of the key drivers for mobile services are:

- *Mobility*: Mobility is the primary advantage of mobile services. Users can get any information they want, whenever they want, regardless of their location, through internet-enabled mobile devices. Mobile services fulfil the need for real-time information and for communication anytime. Through their internet-enabled mobile devices, mobile users may be engaged in activities, such as meeting people or travelling, whilst conducting transactions or receiving information.
- *Reachability*. Through mobile devices, business/government entities are able to reach customers/constituents anywhere, anytime. With a mobile terminal, a user can be in touch with and accessible to other people anywhere anytime. The user can also limit his/her 'reachability' to particular persons or at particular times.
- *Localisation*. The knowledge of a user's physical location at a particular moment also adds significant value to mobile services. With location information available, many location-based services can be provided. For example, with the knowledge of a user's location, the mobile application can alert him/her quickly when his or her friend or colleague is nearby. It can also help the user locate the nearest restaurant or ATM.
- *Personalisation*. Although enormous amounts of information, services, and applications are currently available on the internet, not all information is relevant to all users. Mobile services can be personalised to filter information or provide services in ways appropriate to a tailored user.

2.2 Mobile communication technologies

The growth of mobile services will depend on the development and deployment of enabling technologies. These technologies include, but not limited to, network technologies, service technologies, mobile middlewares, mobile commerce terminals, mobile location technologies, mobile personalisation technologies, and content delivery and format. Presented below are some of the major technologies that are making mobile services a reality:

- *GSM* - operating in the 900 MHz and the 1800 MHz (1900 MHz in the USA) frequency band, GSM (global system for mobile communication) is the prevailing mobile standard in Europe and most of the Asia-Pacific region. It also serves as the basis for other network technologies such as HSCSD (high speed circuit switched data) and GPRS (general packet radio service). The wide adoption of the GSM standard makes it economically feasible to develop innovative mobile applications and services.
- *SMS* - short message service (SMS) enables the sending and receiving of text messages to and from mobile phones. Currently, up to 160 alphanumeric characters can be exchanged in each SMS message. Widely used in Europe, SMS messages are mainly voice mail notification and simple person-to-person messaging. It also provides mobile information services, such as news, stock quotes, sports, and weather. SMS chat is the latest feature and is growing in popularity.

- *WAP* - wireless application protocol (WAP) is an open and global standard for mobile solutions, designed specifically to deliver web information to mobile terminals. As an end-to-end application protocol, it attempts to provide solutions to the challenges in developing mobile applications, such as connecting mobile terminals to the internet and making mobile terminals become capable of communicating with other devices over a wireless network. It also permits the design of interactive and real-time mobile services.
- *UMTS* - universal mobile telecommunications system (UMTS), the so-called 'third-generation (3G)' technology, aims to offer higher bandwidth, and packet-based transmission of text, voice, video and multimedia, which are needed to support data-intensive applications. Once UMTS is fully implemented, computer and phone users can be constantly connected to the internet and have access to a consistent set of services worldwide. Integrating the functions of a whole range of different equipment, a 3G mobile phone can be used as a phone, a computer, a television, a paper, a video conferencing centre, a newspaper, a diary and a credit card.
- *Fourth-generation technologies* - although 3G technologies are just emerging, research has commenced on 'fourth-generation (4G)' technologies. These research initiatives encompass a variety of radio interfaces and even an entirely new wireless access infrastructure. Better modulation methods and smart antenna technology are two of the main research areas that will enable fourth-generation wireless systems to outperform third-generation wireless networks [2].
- *Bluetooth* - named after a tenth-century Danish king who conquered Scandinavia, Bluetooth is a low power radio technology for communication and data exchange. Using a single chip with built-in radio transmission circuitry, Bluetooth is an inexpensive short-range wireless standard supporting local area networks (LANs). It was developed to replace the cables and infrared links within a ten-meter diameter. Bluetooth can be used to link electronic devices, such as PCs, printers, mobile devices, and PDAs, to wireless data networks [3].
- *GPS* - global positioning system (GPS) is a system of satellites orbiting the earth. Because the satellites are continuously broadcasting their own position and direction, GPS receivers can calculate the exact geographic location with great accuracy. Originally developed in the USA for military use, GPS is now also used for civilian purposes. For example, GPS is used in car navigation systems.
- *XML* - extensible markup language (XML) is a meta-language, designed to communicate the meaning of data through a self-describing mechanism. It tags data and puts content into context, thereby enabling content providers to encode semantics into their documents. For XML compliant information systems, data can be exchanged directly even between organisations with different operation systems and data models, as long as the organisations agree on the meaning of the data that is exchanged. XML is heavily used in mobile applications development.

- *WML* - wireless markup language (WML), derived from XML, has been developed especially for WAP. It allows information to be represented as cards suitable for display on mobile devices. So, WML is basically to WAP what HTML is to the http.

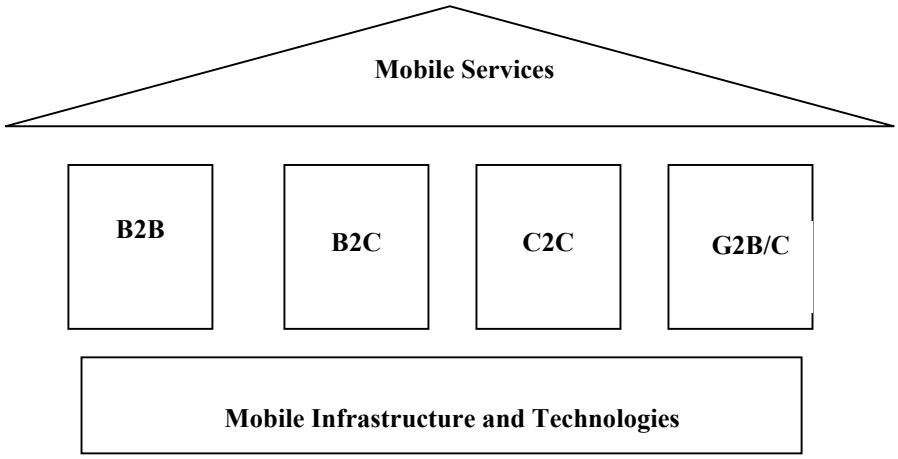
2.3 Types of mobile services

Mobility creates many new opportunities for the business world to embrace. Meanwhile, the current applications can be streamlined by integrating mobility. Adding mobility to services will create anytime/anywhere information access, facilitate information sharing, and provide location-based and presence-based services. Based on the mobile infrastructure and mobile technologies, mobile services can be classified into various categories. In this paper, we will look at four major areas, (see Figure 1):

- mobile B2B
- mobile B2C
- mobile C2C
- mobile government.

Discussed below are some of the current and potential mobile applications in each of these categories:

Figure 1 Mobile service applications



2.3.1 Mobile B2B

Mobile B2B includes mobile transactions within and between organisations. Mobility integrated into organisations' operations has the potential to make information flows more efficient, to coordinate operations within the extended enterprise, and thus improve supply chain management. For example, mobile e-mail and the internet enable instant data and information exchange within organisations and among business partners, and

facilitate information sharing and interactivity within the supply chain network to help businesses cope with complex business environments. With a laptop, a GSM modem and a connected mobile phone, corporate users can dial into the corporate network's mail server and stay in touch with their organisations while on the move. Together with mobile e-mail, the mobile B2B services enable sales professionals and customer care forces to track order status, access marketing information, check customer feedback, report problems, consult with technicians, and identify locations anytime and anywhere. In addition, field technicians can use mobile devices to communicate logistics, machine status, customer information, and order and billing information.

Mobile services can also be used to manage logistics and work flow, and streamline inventory and distribution control. For example, Bluetooth devices are ideal for inventory control. Instead of users making manual connection, Bluetooth devices connect and communicate spontaneously. Instantly linked to the system and easy to handle, Bluetooth devices provide fast data sharing and quick stock check, and enable the supply chain members to share stock data.

2.3.2 Mobile B2C

Mobile B2C transactions are retailing transactions with individual shoppers, known as customers, or consumers. Mobile services can provide customers automated, unassisted operations directly from mobile terminals. For example, United Parcel Services (UPS) has begun to use wireless devices to track shipments, and its customers can determine the estimated delivery time with a PDA or mobile phone. Mobility also promises business units, such as financial institutions, powerful channels to reach out to their customers through always-on, always-with-you mobile devices. Mobile commerce can increase customer satisfaction by pushing information to mobile users, and putting them in a better-informed position. Listed below are some applications in mobile B2C:

- *Mobile financial services* - mobile financial services open a new service channel for financial institutions. They are also a key commercial driver for the mobile commerce market in Europe and beyond [4]. Financial services such as mobile banking and mobile broking, are available at various wireless internet websites (e.g., E*TRADE, Yahoo!Finance, Ameritrade). Companies show great enthusiasm in providing mobile financial services. For example, MasterCard has plans to invest US$5 million in the MIT Media Lab to develop new ways for mobile device users to pay for everything from vending machine items to big-ticket items at retail stores [5].
- *Mobile shopping* - mobility extends the ability of customers to make transactions across time and location, and thus provides them with personalised, immediate opportunities to purchase. Available 24x7, mobile shopping enables customers to make purchases from anywhere, anytime. Customers can make the purchasing decision on the spot and do not have to go to an alternate source. Mobile shopping is now available in many wireless websites. Amazon.com, for example, announced a new URL that allows internet-ready wireless devices to access its shopping services [6].

- *Mobile ticketing.* - ticketmaster online-citysearch (TMCS) offers a service that allows users to purchase tickets using mobile communication devices. The service is reported to give cellular phone users access to tickets, local news and information relating to events at more than 3,750 venues around the United States [7]. The advantage of mobile ticketing is obvious: Customers do not have to go in person to a ticket booth, or to call an agency or an outlet. It is clearly more convenient to select or book tickets for movies, theatres, operas, and concerts directly from a mobile device. Imagine walking down Broadway and having access to ticketing information of all the theatres without needing to physically visit every theatre.
- *Mobile news, sports and other information* - the range of information that can be provided wirelessly is unlimited. Along with news and sports information, many other types of information are now available from wireless devices. For example, 555-1212.com provides mobile telephone and directory assistance services, including yellow pages, international calling codes and e-mail addresses. Citiwiz provides guide to hotels, restaurants and car services around the world.
- *Mobile advertising* - since the location of a mobile device can be determined precisely, the stores around the mobile device user can transmit user-specific information, such as current sales or specials, and alert the user to similar upcoming events. Wireless coupons enable advertisers to deliver geographically targeted and time-sensitive messages to willing consumers directly, with promotional offers virtually anytime and anywhere. Mobile advertising will increase marketing efficiency and allow direct offers suited to user profiles or stated user preferences.
- *Mobile entertainment* - mobile entertainment may take on many forms, such as mobile gaming, mobile music, and mobile video. It presents mobile users new ways to entertain themselves on the move.

2.3.3 Mobile C2C

In the mobile C2C category, consumers sell directly to other consumers via mobile devices. In the near future, individuals will be able to use their mobile handsets to seek potential buyers for their properties, autos, etc., interact and negotiate with them, and conclude transactions. For example, buyers and sellers can interact outside a football stadium regarding tickets on a game day. Individuals can also advertise personal services and sell knowledge and expertise on the mobile internet.

2.3.4 Mobile government

Mobile government is the extension of e-government as the internet goes wireless. It enables people to access government departments and organisations through websites on the internet, regardless of physical location or time of the day, via their mobile handsets. It has the potential to make viable and highly productive connections between government and constituents (G2C), government and business (G2B), government and employee (G2E), and government and government (G2G). In the near future it is expected that mobile constituents will be able to pay taxes, order birth certificates, renew vehicle licenses, reserve campsites and so forth via their mobile devices. In a mobile government age, constituents can expect more convenience, responsiveness, and personalised services from their governments.

3 Organisational and technological issues

The prospect of mobile applications may appear obvious to many, but the path to success is not necessarily obvious and smooth. Current technical limitations of mobile devices and wireless communication, coupled with business concerns complicate the development of mobile applications. In this section, we elaborate on the challenges and obstacles in adopting mobile applications:

- *Strategy changes* - to stay competitive and realise genuine productivity benefits from mobile services, many organisational processes need to be redesigned to fully integrate mobile services. They will have to make fundamental changes in organisational behaviour, develop new business models, and eliminate the inefficiencies of the old organisational structures. The process of rethinking and redesigning is a demanding task. For example, implementing mobile government is more than developing a web site on the mobile internet. Actually, the problem involves rethinking and reengineering the way government conducts business. Unlike traditional government, which is organised around agencies and bureaucracies, mobile government in the information age will be deployed around the needs of its citizens. This entails rethinking how government should be organised from the perspective of its citizens, and reengineering how government could better perform its functions according to the needs of its citizens, rather than to the requirements of bureaucracies.
- *Investment risk* - a major problem faced by mobile services is the huge investment required for their implementation and operation. Engineering massive organisational and system changes to strategically reposition an organisation is complicated as well as expensive. For example, a company will have to build a mobile infrastructure and invest money in mobile devices. But implementing the mobile technology itself does not guarantee that an implementing organisation will reap any benefits from mobile services. Expertise in fields other than technology is also a prerequisite for successful applications of mobile services. How can organisations obtain a payoff from their investment in wireless technology? Understanding the costs and benefits of mobile commerce is difficult, particularly when the technology is changing and evolving at a rapid pace.
- *Mobile devices limitations* - current wireless devices include phones, hand-held or palm-sized computers, laptops, and vehicle-mounted interfaces. Whilst mobile terminals demonstrate a greater extent of mobility and flexibility, they are inferior, in several aspects, to personal computers or laptops. The screen is small and the display resolution is low. The small and multifunction keypad complicates user input. Because of the need to be physically small and light, these input and output mechanisms impede the development of user-friendly interfaces and graphical applications for mobile devices. Mobile handsets are also limited in computational power, memory and disk capacity, battery life, and surfability. These drawbacks in mobile devices do not support complex applications and transactions, and consequently limit usage of mobile services in complicated business environments. However, mobile communication technologies and devices are advancing in leaps and bounds and many of the existing limitations will disappear.

- *Incompatible networks* - multiple, complex and competing protocols exist in today's cellular network standards. As previously mentioned, GSM is a single standard used by the network operators in Europe and the Pacific Asian region. But TDMA (time-division multiple access) and CDMA (code division multiple access) are widely used in the USA. These different standards have resulted in the global incompatibility of cellular handsets. The network incompatibility poses problems for companies in communicating with their customers.
- *Competing web languages* - in addition to incompatible networks, there are a number of competing web languages. Newer mobile phones will incorporate WAP and its WML. On the other hand, NTT DoCoMo's iMode uses condensed HTML (hyper-text markup language). The fact that incompatible standards are utilised in mobile devices today makes the process of creating successful m-commerce applications even more difficult. The need for standardisation of web languages appears extremely urgent. The mobile communications within organisations and the interactions between organisations and their customers will not see significant improvements until the issue of competing web languages is addressed.
- *Security concerns* - compared to its wired counterpart, wireless communications are more vulnerable. Although most wireless data networks today provide reasonable levels of encryption and security, the technology does not ensure transmission security in the network infrastructure. Data can be lost due to mobile terminal malfunctions. Worse, these terminals can be stolen and ongoing transactions can be altered. In short, the mobility enjoyed by m-commerce also raises many more challenging security issues. Serious consideration must be given to the issue of security in developing mobile applications.
- *Trust* - in each transaction, each party involved needs to be able to authenticate its counterparts, to make sure that received messages are not tampered with, to keep the communication content confidential, and to believe that the received messages come from the correct senders. Due to the inherent vulnerability of the mobile environment, users in mobile commerce are more concerned about security issues involved with mobile transactions. According to Marcus [8] US consumers are not ready to buy mobile services. They first need to be assured that their financial information is secure, and that wireless transactions are safe. The mass adoption of mobile commerce will not be realised until users begin to trust mobile services [9].

4 Research issues

Research plays a vital role in solving problems in current mobile applications. In this section, we delineate the research that should be carried out to address the challenges facing the field:

- *Identify killer application(s)* - a killer application for a computing platform is "an application compelling enough to motivate purchases of that platform"[2, p.9]. For example, access to the internet is the killer application that spurred PC purchases in the second half of the 1990s. For mobile services to succeed, one or more killer applications must be developed to compel individuals to purchase and use mobile devices in their daily and commercial activities. The killer application(s) for mobile services should take full advantage of mobility, provide services directly relevant to the needs of mobile users, and benefit users in immediacy and efficiency.
- *Enhance usability of mobile devices* - currently, the usability of mobile devices is poor due to the various limitations of mobile terminals. Future mobile devices are expected to be smaller and more wearable, and they will possess larger processing capability and storage capacity. Screens for cellular phones will be made larger, making them easier to read and more visually appealing. Meanwhile, offline methods that require no direct connection of mobile devices to the network can help to minimise the technical limitations. Future mobile devices will also support Bluetooth technology allowing them to access nearby appliances such as vending machines and televisions using very low cost short-range moderate bandwidth connections. With such capabilities, mobile devices will support a combination of different communication connections to provide a variety of mobile services.
- *Design user-friendly interface* - unlike the wired computing environment where large screens are available, mobile applications have to operate on small and often wearable mobile devices that can only include small screens. Researchers are now developing voice-based and pen-based interaction to replace the present keyboard and mouse interaction. Pen-based interaction on touch screens may replace the mouse; voice-based interaction may be used for activation and control of functions such as voice dialling. Some studies on the user interface for mobile devices have been reported in the workshop series on human computer interaction with mobile devices [10].
- *Consolidate network infrastructure* - bandwidth and coverage are major issues for network infrastructure [11]. The former allows more data to be exchanged between servers and mobile devices, thus supporting multimedia content delivery. The latter minimises the complications of connection losses when a mobile device moves beyond a network boundary or crosses from one network to another. These two issues directly affect the quality of mobile data transfer, and therefore are critical to the further development and future deployment of mobile applications.
- *Develop content delivery and a format for mobile commerce* - at present, much attention has been given to providing visual access to web content. As a result, WML and compact HTML (cHTML) are now widely used. Voice access can also be employed to enable web content to be displayed on mobile devices. VoiceXML [12]. is a new markup language for creating voice-user interfaces to web applications or content using normal telephones. Since most mobile devices can be equipped with voice capabilities, it is important to study how a combined voice, screen and keyboard (or button) access to the web can be realised by integrating the features in VoiceXML with wireless markup language.

- *Improve mobile access to databases* - to allow users to run applications on their mobile devices without having to maintain constant connection with the servers and pay expensive connection fees, at least part of the database systems must be able to reside on the mobile devices. It will be necessary for these mobile database systems to require little memory and to be able to transfer their data to the centralised database systems or to synchronise their databases with those at the centralised database systems. In some cases, a mobile database system may only manage a portion of a large central database pulling in additional data on demand and pushing back data that is not required. In a mobile environment where users are constantly on the move and few computing resources are available, query processing and data recovery capabilities for these mobile database systems will have to be further improved.
- *Explore agent technologies* - the relatively high cost of connection time and data exchange for mobile devices discourages the adoption of mobile applications by cost-sensitive organisations. Agent technologies can alleviate this problem. Mobile users can contact agents to look for products and services, to locate merchants, to negotiate prices, and to make payments. All of these activities can be performed without having the mobile devices constantly connected to the network. In an agent-based mobile commerce framework, agents can be envisioned as merchants, consumers, and other brokering services, interacting with one another to enable electronic transactions.
- *Address security issues* - research on how to improve security in mobile commerce must be carried out, due to the vulnerability of mobile devices and wireless networks. To meet security requirements such as authentication, integrity, confidentiality, message authentication, and non-repudiation in mobile commerce, additional security software and features (e.g. certificates, private, and public keys) will have to be installed on mobile devices. However, due to the limited computing capability of mobile devices, at some point it might be necessary to establish additional servers to store information, perform security checking, and conduct electronic payments on behalf of mobile devices [13].

5 Conclusion

Mobile services have the potential to significantly and positively impact the way we do our business. Though there remain a number of technical, regulatory, and social challenges to overcome, mobile communications and mobile devices will continue to develop and incorporate additional functionality in the coming years. Undoubtedly, mobile services will blossom with the advancement in mobile communication technologies.

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