From E-Commerce to M-Commerce

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Abstract: It is estimated that by 2003 the world-wide number of mobile subscribers will be over 1 billion. Most of this mobile usage growth will come from new applications tied to data. The huge growth in mobile communications, coupled with the development of new data standards and protocols (e.g. WAP), gives rise to the mobile commerce revolution. Mobile commerce represents an extension of the Internet beyond the static terminal into the "anywhere anytime" context. Mobile commerce is driving fundamental changes in the way business is conducted. In this paper, the enabling technology and services around mobile commerce will be described.

I. Introduction:

Mobile communication services have been widely deployed around the world. The associated industry has grown by orders of magnitude. By 2003, the number of mobile subscribers will be over 1 billion. Moreover, the number of Internet-enabled mobile devices will exceed the number of Personal Computers (PCs). Mobile commerce is generally defined as any transaction with a monetary value that is conducted via a mobile network. It is about extending e-commerce to mobile phones. The market for mobile commerce is worth $3.5 billion in 2000. It is expected that this will rise to more than $200 billion in 2005. Mobile access to e-commerce is important for the following reasons:

- The number of mobile terminals is growing faster than the PC user base.
- Users carry mobile phones with them far more than they do with their PCs
- Mobile terminals extend the access to anywhere anytime.

Mobile commerce is extremely important for a wide range of industries such as finance, telecommunications, IT, media and retail. The mobile commerce players are

- Network operators.
- Device manufacturers
- Infrastructure vendors
- Financial service providers
- Content providers

Mobile commerce will propagate in three broad waves:

- The first wave is characterized by simple consumer and professional applications such as e-mail access, stock quotes and weather and news reports. Also, such services exist as a result of single partnership between operators and finance providers.
- The second wave will provide personalized interactive applications (e.g., location-based services). Better security and network capability will also be provided.
- The third wave will offer greater bandwidth and capacity which will facilitate multimedia applications.

In this paper, the enabling technology and services around m-commerce will be described. Moreover, the opportunities provided for new information and e-commerce services will be presented. Finally, the benefits they will offer to businesses and public sector organizations will be illustrated.

Section II will give a brief description of the major mobile communication technologies that have been deployed. The services and protocols that facilitate mobile commerce will be discussed in Section III. Then, mobile commerce applications will be summarized in Section IV. Finally, the paper will be concluded with a brief discussion on the current challenges to mobile commerce.

II. Mobile Communication Systems:

Cellular systems are by far the mostly deployed wireless systems. By the end of 1999, the worldwide cellular subscriber base reached 470 million (a worldwide penetration of 8%). Moreover, worldwide cellular services revenues reached US$280 billion in 1999. The number of cellular subscribers is expected to reach 1.4 billion by 2005 with annual revenues of US$670 billion. This represents a worldwide cellular market penetration of 21%. By 2005, cellular penetration will have passed 84% in Western Europe while North American penetration will approach 80% [1].

From a technology perspective, the two dominant access techniques are TDMA and CDMA. This classification is based on how users are allowed to share the radio spectrum.
In Time Division Multiple Access (TDMA) based systems, each user is allocated a time slot. The IS-54/IS-136 and GSM systems are based on TDMA. In Code Division Multiple Access (CDMA) based systems, each user data is multiplied by a Pseudo-Noise (PN) sequence. Multiplication by the PN sequence will result in a spread of the signal over a wide spectrum. If the users' PN sequences are orthogonal, then multiple users can share the same channel (which will have a wide bandwidth). Therefore, the number of users on each channel is not a hard limit but depends on the system's acceptable noise level.

There exist four major digital cellular technologies. The US system (IS-54) represents the first digital cellular system in North America. It is commonly named as D-AMPS. It was used to satisfy the increasing demand on cellular services since its capacity is three times that of the analog system (AMPS). It uses the same frequency scheme used by the AMPS. The IS-136 system is an extension of the IS-54 system. It is designed to work in the PCS frequency band. It has the additional main feature of short message services (SMS). By mid 2000, the total number of D-AMPS/IS-136 subscribers is around 50 million [2]. The Pacific Digital Cellular (PDC) standard is the Japanese version of D-AMPS. There are about 48 million PDC subscribers as of mid 2000 [2].

The IS-95 standard is the first digital cellular standard that is based on CDMA technology. First mobile phones using the IS-95 standard were introduced by Qualcomm in 1994. They offer greater capacity than TDMA based systems. However, its performance is highly dependent on power control. By June 2000, CDMA subscribers reached 65 million.

The Global System for Mobile (GSM), introduced in 1992, represents the first digital cellular system in Europe. It uses FDD, TDMA and FHMA access technologies. It was designed to allow users to roam between European countries. Currently, it is the world's largest deployed cellular standard with more than 380 million subscribers in 373 GSM networks and 159 countries [2]. It is also growing at a very high rate that is twice what the industry predicted. GSM will continue to dominate the worldwide digital cellular market. The number of GSM subscribers is expected to reach 750 million by 2005 [1].

The GSM system provides voice and data services. Early data services in GSM are based on circuit-switching technology. An uplink and downlink channels are reserved for one user for the entire session duration. The setup time is long and the user pays for the amount of time not the amount of data transferred. Moreover, the available data rate is 9.6 Kbps (14.4 Kbps can be achieved with advanced coding methods). This rate is not suitable for Internet access or multimedia applications

The General Packet Radio Service (GPRS) is a packet-switching technology that can be used with current GSM infrastructure to support packet-based transmission over GSM networks. It is based on the principle that resources are reserved only when needed and charged accordingly. This service offers the advantage of flexible channel allocation and reduced setup time.

The maximum bit rate that can be obtained with GPRS is 171.2 Kbps. Immediate connections to the data network can be obtained; i.e., there is no need for a dial-up modem connection. GPRS can be used to carry IP based applications, X.25 and GPRS specific protocols. Therefore, GPRS will fully enable mobile Internet functionality by allowing interworking between the existing Internet and the GPRS network. Any service that is used over the fixed Internet today – (e.g., www, ftp, e-mail, etc) will be also available over the mobile network. As a result, GPRS will enable mobile operators to become wireless Internet Service Providers.

GPRS can be activated by adding additional elements in the network. However, GPRS has two main limitations which are the limited cell capacity for all users and the relatively slow speed. The Enhanced Date Rate for GSM Evolution (EDGE) is a higher bandwidth version of GSM that permits higher data rates, up to 384 Kbps.

The International Mobile Telecommunications by the year 2000 (IMT-2000) is an initiative of ITU-Radio, Task Group 8/1. The main objective of IMT-2000 is to unify diverse systems into one universal system that can be used worldwide. Other objectives of the IMT-2000 are as follows

- Customers should see services, not technology
- Provide a seamless radio infrastructure
- Maximize commonality of radio interfaces
- Enable cost-effective dual-mode operation
- Universal personal mobility
- Evolution from 2nd generation technologies

The IMT-2000 is being designed for a wide range of services (voice and non-voice/multi-media), a wide range of propagation environments (indoor/outdoor) and a wide range of user densities, with a performance comparable to that of fixed networks. IMT-2000 will deliver bit rates up to 384 kbps for wide-area coverage and 2 Mbps for indoor or fixed applications. The system is required to have an open architecture. Moreover, the IMT-2000 must provide a seamless path of migration from second generation wireless networks. As a result, the IMT-2000 standard will allow five different modes:

- Direct Spread CDMA
- Multi-Carrier CDMA
- TDD CDMA
- TDMA/FDMA
- Single-Carrier TDMA

The first 3G network is expected to be deployed by NTT DoCoMo of Japan in 2001. More details of the system can be found in [3].

III. Mobile Commerce Services and Protocols: Many services that facilitate mobile commerce exist today. Short Message Services (SMS) is the most basic service available. SMS allows users to send and receive text messages to and from mobile phones. SMS usage has grown exponentially, The number of SMS messages has nearly doubled every year since 1998. In June 2000, the number of SMS messages reached 8 billion messages over the month. It is expected that by the end of 2000, the number of SMS messages will reach 10 million per month [2].

The Wireless Application Protocol (WAP) is an open standard for presentation and delivery of information from the Internet to mobile phones, pagers and personal digital assistants [4]. It has the same role as that of web browsers in wired networks. It is designed to work with most wireless networks, such as GSM, GPRS, CDMA, TETRA, DECT, etc. It has the advantage of providing a medium to connect in a secure, fast and interactive way with services, information and other users.

The WAP Forum has been established in June 1997. It is an industry association comprising over 200 members. It is responsible for developing the WAP standard to ensure product interoperability. The WAP layers are modeled to the HTML/HTTP/TCP/IP protocol stack. Security is handled through the WTLS protocol, which is based on the SSL protocol.

The WAP Forum released v1.0 in April 1998. Later, v1.1 was released in June 1999. This version is currently being used by most devices. WAP 1.2 is the latest release and it supports "push" technology, which allows web servers to dynamically send information to a WAP phone without a client's request. The number of WAP phones is expected to reach 26 million by the end of this year [4].

The Microsoft's Mobile Explorer is a competitor of WAP. It has the advantage that it can read html pages. This means that web developers do not have to create specific versions of their sites like they do for WAP-enabled devices.

The current leader in using mobile phones for web access is the Japanese i-mode. It is a proprietary system developed by NTT DoCoMo. In i-mode, html pages are translated to a format useable by mobile phones. It offers many interactive on-line web services, such as sports scores, banking, stock trading, weather forecasts, maps, tickets and others. As of July 2000, the number of i-mode subscribers reached 10 million. Although the Mobile Explorer and i-mode have an advantage over WAP, it is still being supported by major mobile phone vendors.

IV. Mobile Commerce Applications:

Financial applications are the key driver for the mobile commerce market. On-line banking and stock brokerage are growing tremendously. Taking this growth to the mobile device will open a new service channel for financial institutions. A brief about some current and possible financial applications is presented below:

- Mobile Banking: 94% of the banks in Europe are offering now on-line banking. Mobile banking is a subset of on-line banking. Currently, SMS is being used to facilitate this application. The following services can be offered through mobile banking:
    - Checking exchange rates
    - Checking account and credit card balance
    - Checking transactions
    - Fund transfer
    - Paying invoices
    - Others
- Mobile Advertisement: Mobile phones have the advantage of allowing one-to-one marketing. Currently, mobile advertising has been carried out using SMS. In the future, advertising can include audio, picture and video clips on the mobile phone screens.
- Mobile Payment: Although no standards have emerged for mobile payment, different systems around the world exist.
- Mobile Broking: Delivering financial information regarding the stock market is a very useful aspect of mobile broking. Currently, many on-line brokers are offering mobile trading via mobile phones or PDA's. Users can buy/sell stocks and execute other financial transactions, check quotes, receive price alerts, receive order execution confirmation and manage portfolios.
- Mobile Reservations: Mobile users can make restaurant reservations and select items from the menu. Using push technology, the user can receive advertisements about restaurants in the user's area and the phone can give directions from the current location to the destination using GPS technology.
- Mobile Ticketing: It is now possible to book or buy travel or movie tickets by mobile phones. A mobile ticket shop is already in place for different commercial operations.
- Mobile Entertainment: Different applications such as mobile gaming, mobile music or mobile video are in place or will appear soon.

V. Conclusions:

Mobile communications will provide new opportunities that are not feasible with PC Internet. Companies will be able to offer personalized services aligned to specific times and locations. The amount that users spend on mobile commerce services will rise to more than $200 billion in 2005. Demand for mobile banking, payment, shopping and entertainment will grow substantially. However, some challenges still face the mobile commerce community (e.g., security, low-display capabilities, low-power devices, limited storage). The industry is working to provide solutions to these challenges.

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