M-Commerce-Issues and Challenges

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Abstract—**There has been a tremendous growth in wireless technology in the last decade. This advancement has changed how people do business in Mobile Commerce (M-Commerce) environment. For creating a more secure and flexible m-commerce infrastructure so as to meet the new demands, we need to leverage new technologies like 3G/UMTS, Bluetooth, EDGE and at the same time utilize the older ones like WAP, GSM, HSCSD, and GPRS. M-Commerce offers the possibility of an entire new level of financial flexibility, taking advantage of both social and technological developments. Several M-Commerce issues relating security, bandwidth, and business are discussed in this paper to meet the challenges of future commerce using mobile wireless technology.**

I. Introduction

WHILE electronic commerce (e-commerce) continues to impact the global business environment profoundly, technologies and applications are beginning to focus more on mobile computing and the wireless Web. With this trend comes a new set of issues specifically related to mobile e-commerce. The purpose of this paper is to examine some of these issues so that researchers, developers, and managers have a starting point for focusing their efforts in this new domain.

In very simple terms, one can say:

M-commerce = E-commerce + Wireless Web.

The days of initial euphoria over the possibilities of mobile technology have transitioned into a time of more cautious enthusiasm. Instead of simply wanting to go mobile, companies are asking for proof that the introduction of mobile services will add value to their businesses. The most important fact is that now mobile touches many areas other than just simply targeting customers. Furthermore, companies initially focused on B2C (business-to-consumer) mobile solutions, are now finding that B2E (Business to Employee) applications to be more strategic. B2E is Business-to-Employee, an approach in which the focus of business is the employee, rather than the consumer (as it is in business-to-consumer, or B2C) or other businesses (as it is in business-to-business, or B2B). [5] The B2E Solution Set enables global enterprises to fully unlock the potential of their businesses, and optimize their existing assets, through the use of Web-based Portal technologies. B2E moves a wide variety of work to the Web, improving collaboration, productivity and operational efficiency among key stakeholders of any organization by making critical information and tools easily accessible and usable, regardless of an individual's role or location. The mobile technology continues to evolve and present an exciting range of possibilities for both near and long-term solutions. The technologies that once seemed a distant promise such as bluetooth, location-based services and telematics, are moving closer to becoming a reality. This fact can make service provider to be capable of providing value-added mobile solutions. Companies are finding that there is no need to simply wait on the sidelines for these next-generation developments to occur, they can leverage devices already in users hands such as non-WAP phones and sync PDAs (personal digital assistants) and readily available technology to introduce equally innovative, strategic solutions today.

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A. Definition of Mobile-Business (M-Business)

M-Business is defined as the exchange of goods, services, information and knowledge with the aid of mobile technology. It encompasses a range of mobile activities, from communicating with colleagues using email, to receiving product information via SMS alerts, to transmitting customer orders with a wireless PDA. M-business includes not only consumer-facing applications but also enterprise solutions that enable companies to operate more efficiently, better serve customers, and generate additional revenue. It can affect the way that companies maintain their operations, organize employees, and keep track of inventory. Mobile Commerce (M-Commerce), on the other hand, is simply defined as the mobile execution of transactions. Buying a movie ticket on a WAP phone is an example of M-Commerce, while retrieving information about that film from a voice portal is not. Simply put, M-Commerce is a subset of m-business. M-business is any mobile function that adds demonstrable value to a company, whether it directly results in the generation of a sale or not. While M-commerce is a vital part of M-business, it is by no means the only measure of its potential uses.

B. Goal of the paper

The goal of this paper is to explore and present the number of possible issues in mobile e-commerce on which others can speculate. M-commerce (mobile commerce) is the latest high-tech buzzword that turns advanced mobile phones and PDAs (Personal Digital Assistants) into devices, which allow direct access to information while on the move. As a result, new opportunities for businesses are arising. We are trying to bring out potential benefits and challenges associated with this new technology. It is very essential in todays competitive business world to know the technology completely before adopting it as a critical tool for doing business. Our paper will help in understanding the current state of this ubiquitous computing technology.

II. Achievements so far

Wireless media has gone under a rapid innovation process in search for a reliable, simple and business-viable solution to consumer demands for fast, easy, and inexpensive

information access. Over the last few years, a number of wireless protocols have been developed and a variety of application vendors have begun to ship wireless products to the market. In fact, the word "wireless" has become a staple buzzword synonymous to "cutting edge" in the software and content sales vocabulary. The protocol specifications contain the clear description of today's wireless media capabilities. This section describes and compares (in both technical and commercial spheres) the specifications of the developed Network Technologies and Service Applications. The analysis of wireless protocols and their interaction with existing Internet infrastructures are based on two specific areas: protocol efficiency and Internet-wireless communication security (including authentication, access control and authorization functions). These two disciplines often play important role in protocol viability. The analysis focuses on the Network Technologies like GSM, HSCSD, GPRS, EDGE and UMTS/3G and with the Service Applications like WAP, iMode, and LEAP specifications. J2ME, EZWeb, and J-SkyWeb documentations have a limited use.

A. Network technologies

In general all the mobile protocols are very similar to each other, being client-server based, enabling a continuously increasing amount of services to be provided to the users. Although the protocols are very similar to each other but still the variety of protocols is introducing some challenges to the adoption of wide spread M-Commerce. This is because it is more difficult to get a certain critical mass of subscribers to use a universal technology to enable frictionless service providing. The future will show which of the following protocols is going to deliver the strongest commercial value at any point in time and will be supported by the largest number of attractive applications.

A.1 GSM

GSM (Global System for Mobile Communication) [5] operates in the 900 MHz and the 1800 MHz (1900 MHz in the US) frequency band and is the prevailing mobile standard in Europe and most of the Asia-Pacific region. GSM is being used by more than 864 million people (end May 2003). Now GSM accounts for approximately 72 percent of the total digital wireless market today. Today's GSM platform is a hugely successful wireless technology and an unprecedented story of global achievement. In less than ten years since the first GSM network was commercially launched, it became the world's leading and fastest growing mobile standard. Spanning over 179 countries, today GSM technology is in use by more than one in ten of the world's population and growth continues to soar with the number of subscribers worldwide expected to surpass one billion by the end of 2004. In Europe, the common GSM standard provides the critical mass to make it economically feasible to develop a large variety of innovative applications and services. Thus, it likely that Europe and Asia will be at the forefront of the development in m-commerce and about 2 years ahead of the US.

A.2 HSCSD

HSCSD (High Speed Circuit Switched Data) is a circuit switched protocol based on GSM. It is able to transmit data up to 4 times the speed of the typical theoretical wireless transmission rate of 14.4 kbps (kilo bytes per second), i.e. 57.6 kbps, simply by using 4 radio channels simultaneously. The key problem in the emergence of this market is that there is currently only few manufacturers who can provide PCMCIA modem cards for HSCSD clients, which offers a transmission speed of 42.3 kbps downstream and 28.8 kbps upstream. It is therefore likely that HSCSD is never going to reach widespread popularity except in some regions as means to connect laptops to the Internet. The situation that the system is facing is typical to all the wireless network options as the technologies develop at such a great speed that few operators wish to invest into a system, which is going to be outperformed by others in a very short period of time.

A.3 GPRS

GPRS (General Packet Radio Service) is a packet switched wireless protocol that offers instant access to data networks. [5] It will permit burst transmission speeds of up to 115 kbps (or theoretically even 171 kbps) when it is completely rolled out. The real advantage of GPRS is that it provides a connection (i.e. instant IP connectivity) between the mobile terminal and the network but the actual capacity would be consumed only when data is actually transmitted. Pilot GPRS networks are already in place today in many European markets. However, GPRS will require new terminals that support the higher data rates, and these seem to be the bottleneck to the early adaptation of the technology.

A.4 EDGE

Enhanced Data Rates for Global Evolution (EDGE) is a higher bandwidth version of GPRS permitting transmission speeds of up to 384 kbps. The number of EDGE users worldwide is set to reach 331.4 million by the year 2007, according to predictions by the experts. This will achieve the delivery of advanced mobile services such as the downloading of video and music clips, full multimedia messaging, high-speed color Internet access and e-mail on the move. It will bring about the modulation changes that will be necessary for UMTS at a later stage. While a number of mobile operators are considering implementing EDGE as an interim data technology between GPRS and UMTS, the success of EDGE depends very much on the timely availability of the products and applications. The opportunity window for EDGE will be very short, unless major delays occur during UMTS deployment.

A.5 3G/UMTS

Standing for "Universal Mobile Telecommunications System", UMTS represents an evolution in terms of services and data speeds from today's "second generation" mobile networks [6]. As a key member of the "global fam-

ily" of third generation (3G) mobile technologies identified by the ITU, UMTS is the natural evolutionary choice for operators of GSM networks, currently representing a customer base of more than 850 million end users in 195 countries and representing over 70% of today's digital wireless market [source: GSM Association]. Using fresh radio spectrum to support increased numbers of customers in line with industry forecasts of demand for data services over the next decade and beyond, "UMTS" is synonymous with a choice of WCDMA radio access technology that has already been selected by approaching 120 licensees worldwide. UMTS is already a reality. Japan launched the world's first commercial WCDMA network in 2001, and WCDMA networks are now operating commercially in Austria, Italy, Sweden and the UK with more launches anticipated during 2003-2004. Several other pilot and pre-commercial trials are operational in the Isle of Man, Monaco and other European territories. Some 200 operators worldwide are also giving their customers a taste of faster data services with so-called "2.5G" systems based on GPRS technology - a natural evolutionary stepping-stone towards UMTS. Many operators are also advancing plans to deploy EDGE technology to increase the speed and capacity of mobile services offered in their current GSM frequency allocations.

B. Service technologies

B.1 WAP

WAP is a patented protocol widely marketed in the US and an "official" wireless standard in the European Union. WAP was first published in April of 1998 by WAP Forum - an industry association of wireless device manufacturers, service providers, and software companies, founded in July of 1997 by the leading industry houses. WAP's design accommodates all the following wireless networks: CDPD, CDMA, GSM, PDC, PHS, TDMA, FLEX, ReFLEX, iDEN, TETRA, DECT, DataTAC, Mobitex, SMS, USSD, CSD, and IS-136. WAP utilises a set of WAP-developed transmission protocols to transfer content from Internet to users' devices. These underlying protocols include WCMP, WDP, WTLS, WTP, and WML. The current WAP-based services charge users by the time duration of their data transfer, the prices being closely correlated with the phone-service charges on their devices. All web-content accessible through the web is developed in a standard HTML. When a user makes an access request to a Web site through a WAP-enabled wireless device, the Web site content is translated by the user's wireless service provider (WSP) from HTML to WML, and then sent to the user. The connection from WSP to a content provider (Origin Server) is an Internet link with SSL encryption enabled as required. The wireless transmission of content radio packets is encrypted using Wireless Transport Layer Security protocol (WTLS), which is discussed in detail in Security section of this document.

B.2 J2ME

J2ME technology is developed using JAVA in the wireless communication field. Java's security model is matured and provides sound and secure Java-based wireless communication. On the other hand, Java's performance ratings have not been all satisfactory, especially on low-powered machines with limited processing capacities, such as the current generation of wireless devices. Speculations are circling in technical community of the feasibility of Java-based wireless devices given the Java performance metrics and hardware requirements for efficient Java processing and low cost preference of customers of wireless devices.

B.3 I mode

I-mode gained a wide acceptance in Japan and is now expanding to Europe despite WAP adoption as a European wireless communication standard. I-mode uses compact HTML for delivery of content and packet switching to sustain continuous connection at a data transfer speed of 9.6 kbps. By far the cheapest wireless access service in the world, I-mode costs US$3 in monthly subscription fees and additional US$0.003 for each 128-bit data package received or transmitted, including content (news, music, etc.) provided by 30,000 DHTML sites. Content charges are billed by content providers extra to the subscription fees, and average US15 per month per subscriber. I-mode content is developed and distributed in compact HTML format, which is a reduced version of HTML. The format supports a number of HTML tags and several binary formats, such as GIFs. I-mode terminals do not support JavaScript. The content providers create I-mode sites in compact HTML format, and then upload the content to a Web server, just as they would with regular Web sites. (Since compact HTML is a stripped version of HTML, the content is also accessible via regular Internet browsers.) The DoCoMo server listens for all the requests for information transfer and channels all I-mode message traffic. When a DoCoMo server gateway receives a GET request from an I-mode device user, the DoCoMo gateway performs high-level authentication, authorization and access control, and channels the request over dedicated lines, SSL-encrypted Internet, or unencrypted Internet to content providers apart from accepting and transmitting wireless information packets. The content providers' response travels in the opposite direction through the dedicated lines/Internet to a DoCoMo gateway where the requested content is encoded via a proprietary DoCoMo scheme. Digital radio packets are then sent to a requesting user's device. In the transmission process, DoCoMo gateway measures the number of data packets transferred by a specific user in order to charge the user accordingly. Digital radio packets sent between handsets and radio towers (DoCoMo's gateways) are encoded via a proprietary DoCoMo scheme. No information on the scheme has been made publicly available. Further more, no encryption exists on the I-mode wireless transmission, leaving the wireless transport untrusted. The new I-mode java-enabled 503-generation microbrowser's chip specification is sufficient for 128 SSL encryption of wireless stream

calculations in laboratory testing.

B.4 SMS

Since 1992 Short Message Service (SMS) has provided the ability to send and receive text messages to and from mobile phones. Each message can contain up to 160 (even more) alphanumeric characters [5]. After historically finding it tough going in the GSM markets, during the year 1998 SMS started suddenly to explode. In October 1999, there were about 2 billion SMS messages sent per month within the GSM world, doubling the number six months earlier. About 90are voice mail notifications or simple person-to-person messaging. The rest is mobile information services, such as news, stock prices, sport, weather, horoscope, jokes etc. Additionally, SMS e-mail notification, SMS chat and downloading of ringing tones has been offered recently in some markets. Although SMS is the backbone of current Mobile Commerce it has certain limitations. In a way using SMS is like conducting E-commerce by typing in HTML code each time a purchase is made. The user requires some knowledge, as specific requests have to be typed in to receive the service. Using text-based services is made easier by the introduction of the WAP protocol and devices.

B.5 Light Efficient Access Protocol (LEAP)

LEAP is a wireless access protocol developed by FreeProtocols.org as an open-source response to WAP. LEAP utilizes Efficient Short Remote Operations (ESRO) as the foundation transport layer for its messaging. In LEAP creation, LEAP developers attempted to minimize number of packets required for message delivery and the number of bytes per each packet. The rational behind this effort is the fewer packets are transmitted, the longer is the wireless device battery life, the more is the network capacity, the cheaper the network usage, and less latency is experienced by users of the wireless devices.

B.6 EZWeb

EZWeb protocols co-developed by Japanese, hold the second place in popularity among Japanese consumers with I-mode holding the crown, despite EZWeb's higher transmission speed of 64 kbps (vs. I-mode's 9.6 kbps). The EZprotocols use handheld device mark up language (HDML, which is widely considered almost obsolete) as the communication standard, the relative difficulty of which reportedly deterred many site designers from developing EZspecific content (less than 500 HDML sites exist). Additionally, EZweb service providers continue to support WAP content creators by providing "WAP Editor", a WAP content production tool.

III. Issues in Mobile Commerce

A. Input & output

Handheld and phone devices differ from desktop and laptop computers in several ways. They generally have smaller screen sizes and limited input capabilities. Many handheld devices display only a few lines of text and do not have traditional keyboards. Larger screens and the use of color can enhance usability but at the expense of battery life (although there is continuing research into new battery types). This classic trade-off is driving current design efforts. The vendors are trying to bring in both features in their designs namely, large color screens and longer battery life. Voice interfaces also show potential for use with mobile clients, but currently have limitations including the need to train devices to recognize a users voice, the relative slowness of voice versus other input means, and the exclusion of graphics or other visual information display.

B. Bandwidth

As bandwidth demand increases for new and existing network applications, very soon service provider may face the scarcity of bandwidth. This problem may be partially tackled by reuse of frequencies. Different standards, such as Bluetooth, IEEE 802.11, and others may recommend to use the same frequency range and that may cause interference. One type of interference occurs when a channel employing frequency hopping (for security) interrupts another channel when it briefly steps on the latter channels frequency. Whether such interference becomes problem remains to be seen.

C. Security

Currently, few wireless communication protocols offer encryption of the transmission. In security models of protocols that do have security encryption (such as WAP), there have been identified transmission security weaknesses in current protocols. Following section describes security issues in wireless transmission.

C.1 WAP

WAP offers WTLS-based security. The Wireless Transport Layer Security protocol (WTLS) has been developed with similarities to existing SSL and TLS protocols. WTLS has been patented by WAP Form and subsequently analyzed by various organizations. WAP Forum's changes to TLS protocol in creation of WTLS resulted in security problems. Among these problems are vulnerability to datagram truncation attack, message forgery attack, and a key-search shortcut for some exportable keys

C.2 I-mode

Digital radio packets sent between handsets and radio towers are encoded via a proprietary DoCoMo scheme. No information on the scheme has been made publicly available. Further more, no encryption exists on the I-mode wireless transmission, leaving the wireless transport untrusted. But, the new I-mode java-enabled 503-generation microbrewer's chips specification is sufficient for 128 encryption of wireless stream calculations.

C.3 LEAP

LEAP does not provide a security mechanism in its current specifications. Whether there exists a poor security

system or no security system at all in a wireless protocol implementation, it is quite evident that today's wireless transmission security is not adequate for serious wireless applications.

D. Business

The business press touts wireless access to information, or the "wireless Internet," as a fast-approaching new world that every business will be forced to compete in tomorrow. But as usual, the enthusiasm for whats possible overshadows the many complex issues that will determine how soon business will adopt the new tool. The present state of M-computing is not stable or matured. There are some bewildering structural problems, such as the lack of coherence and stability in standards and protocols in the mobile world, bottleneck in network, the cascade of hardware and software options. But the present problem is not of a new kind. The emerging wireless Internet, today, looks very much like the wired Internet did five years ago. The road ahead in this field is yet to take a definite shape. The uncertainties revolve around the following questions:

- Will consumers adopt the mobile technology?
- And if they do, how will they behave on it?
- Can companies create or capture value by adopting this new channel and if so, how?
- Is it possible to develop broad-based applications at all, given the bewildering array of browsers, access speeds, standards, and emerging functionality such as streaming video?
- Can established companies be m-computing followers, rather than leaders?
- What capabilities are required to make an M-computing in business viable?
- What is the m-computing operating model?

Thus, while the level of the hype may be the same today for the wireless Internet as it once was for the wired Net, but the level of managerial uncertainty should not be. Companies that have built digital businesses during the last five years have a body of experience to draw on for this next leg in the journey. The Internet is a platform for what is to come, a business platform, a technological platform, and a platform for managerial experience. On this basis it is possible to have pervasive, wireless networking in faster pace than the Internet did because companies can leverage the lessons of the past. It is very important because in business winners are those who moved quickly, and in the right ways, to secure a lead advantage in their sector. Additionally, global standards are emerging and wireless access speeds will improve at a dramatic pace, in fact, faster than Internet access speed improved.

IV. Challenges In M-commerce

A. Security

Security is a key enabling factor in M-commerce. GSM provides a relatively secure connection through the PIN (personal Identification Number) when turning on the handset. An authentication protocol between handset and the network through SSL encryption of voice and data is also there in GSM. But it is not enough to convince people. In order to get the confidence of critical mass of consumers, more is expected in the field of security. It looks that the smart cards will be the preferred way of gaining access to a secure system. The smart card can be in the form of a credit card or in the form of a SIM like miniature card [1]. It is possible to run a variety of application on a single small SIM card. Encryption is being used to ensure confidentiality through a secret key in association with the algorithm. This produces a scrambled version of the original message that the recipient can decrypt using the original key to retrieve the content. The key must be kept secret between the two parties. There are two basic methods, which can be used to encrypt a document: symmetric and asymmetric. With the symmetric method the same key is used for encryption and decryption. The problem is that the key has to be transmitted to the recipient of the message, and a third party could gain access to the key during this transmission. Within symmetric encryption both parties have typically a key of 1024 2048 bits. Using asymmetric algorithm, also known as public key methods, a set of two keys is used a private and a public key. Information encrypted using the public key can only be retrieved using the complementary private key.

B. Business

A key challenge that companies will face as they build businesses for the wireless and wired age is that they will need to integrate capabilities and disciplines that are quite separate in most organizations today. These include creative thinking, seasoned business skills, a deep understanding of technology and technical issues in both telecommunications and information systems, an understanding of how all this will evolve, and well-honed skills in design and branding. Executives will need to begin to think now about how to assemble these skills and how to create processes for effectively coordinating them. As they build these new digital businesses, executives should not underestimate what they already know. The lessons learned from the many business successes and failures we have seen during the last five years on the wired Web apply to mobile businesses as well, and to the integrated wired and wireless, on-line and off-line businesses of the future. Going forward from here, the opportunities for success in m-commerce will go to those who focus on creating compelling value for customers, rooted in a deep understanding of the mobile experience, who build dynamic infra-structures for the business, and who forge business models that harvest sustainable value from the offerings and economics of the mobile Web. Executives are also to think about how to tackle the changes that mobile computing will bring about in the organization. Absence of proper management can have negative effect in the performance of business and lead to failure of mobile computing as such.

V. Conclusion

The mobile Internet channel has opened up possibilities that business once dreamed of. There is a big gap between

what the technology can do today and what the consumer has been led to expect. The good news is that the sources of consumer frustration like slow transmission speeds, difficult user interfaces and high costs - are being addressed by operators and equipment manufacturers. M-commerce players will need to move fast to improve the user interface and offer innovative pricing structures. Despite the initial frustrations of the early users, consumers envision that once many of the glitches are worked out, mobile applications will become an integral part of their daily lives. Eighty-two percent of current and potential users think that the mobile device will become their personal travel assistant within the next three years. Eighty-one percent also foresee using these devices as part of their daily routine - for sending emails, getting news and information, and shopping. More than half (61 percent) expect these devices to become universal payment tools. Given this high level of consumer acceptance, the report predicts that by 2003, m-commerce will be where the Internet was in 1998 in terms of transaction value. In the B2C, total revenues generated by m-commerce will reach approximately $100 billion, half of which will come from data transmission charges, e-mail subscription fees, and advertising; the other half will come from the value of transactions and related activities via mobile devices.

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