A Framework for m-Commerce: A Consumers' Perspective

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Abstract

The phenomenal growth in the use of cellular phones and, more recently, also of wirelessly enabled Personal Digital Assistants (PDAs), is giving rise to yet another revolution in the business world. This revolution is focused on conducting business on the move or mobile commerce (m-Commerce). This trend is fueled by a consumer interest in being able to access business services or to communicate with other consumers anytime and anywhere. It is also motivated by the interest of the business community to extend their reach to customers at all times and at all places. This paper starts by exploring the similarities and differences between m-Commerce and e-Commerce, followed by an overview of the technologies that support m-Commerce and in particular wireless networks, protocols and devices. A framework for analyzing the types of interactions that a typical consumer might be engaged in within a wireless environment is then introduced. An analysis of the various consumer needs and concerns for m-Commerce services/products is then presented. Several business applications are explored in the context of the proposed framework. Finally, the necessary business and technological requirements for the ultimate success of these m-Commerce applications are discussed along with some managerial implications.

Keywords: m-Commerce, e-Commerce, m-Consumer, wireless networks, wireless devices, wireless protocols, m-Consumer needs, m-Consumer concerns, connectivity, communication, entertainment, m-Commerce business applications.

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1. Introduction

Less than a decade after the e-Commerce revolution and its associated global impact on the business environment, it appears that another step has been taken in the evolution of networked computing. Transitioning from wired to wireless networks, the latest buzz in the industry is mobile commerce or m-Commerce [1].

m-Commerce could be viewed as a subset of e-Commerce. The name "m-Commerce" arises from the mobile nature of the wireless environment that supports mobile electronic business transactions. Devices, including digital cellular phones, Personal Digital Assistants (PDAs), pagers, notebooks, and even automobiles, can already access the Internet wirelessly and utilize its various capabilities, such as e-mail and Web browsing, for example [2]. m-Commerce is a natural extension of e-Commerce as they share fundamental business principles, but m-Commerce acts as another channel through which value can be added to e-business processes. It also provides for new ways through which evolving customer needs could potentially be met [3].

Businesses and consumers are two distinct types of customers that exist in the m-Commerce industry. The focus of this paper will be on the mobile consumer (m-Consumer) segment of the m-Commerce market. The paper starts with an introduction outlining the main similarities and differences between m-Commerce and e-Commerce, as well as providing an overview of the technologies used to support m-Commerce activities, and the m-Commerce market. In Section 2 a framework is introduced, which identifies the various entities involved in consumer-focused m-Commerce activities and their different modes of interaction. We then turn our attention to analyzing the associated needs and concerns of the m-Consumer in Section 3. We then present current and future applications addressing those needs in Section 4. Finally, Section 5 provides a

discussion summarizing the main findings of this research and outlining some solutions for identified m-Consumer concerns as well as some associated managerial implications.

1.1 Differences between m-Commerce & e-Commerce

The m-Commerce and the e-Commerce business environments and activities have a lot in common. This is the case since they involve much of the same functionality in terms of facilitating electronic business over the Internet. However, some differences exist in the mode of communication, the types of Internet access devices, the development languages and communication protocols, as well as the enabling technologies used to support each environment. Differences in these four areas are explored below in more detail [2].

- **Communication Mode:** The main mode of conducting wired e-Commerce is through a wired connection to a Local Area Network (LAN) while that for m-Commerce is through a wireless network. This is a fundamental difference between the two environments as it enables customers to engage in e-Commerce anytime/anywhere using various forms of wireless communication devices (e.g. cell phones or PDAs).

- **Internet Access Devices:** Wired e-Commerce is conducted mainly through desktop and laptop computers. m-Commerce, on the other hand, is conducted through a variety of wireless devices including cell phones, PDAs, and wireless-enabled laptops. Since most of these devices are more personal in nature than the usual desktop (i.e. they tend to be used by a single user who carries the device at most times), the potential for offering personalized products/services is higher. This trend is further enhanced by the ability of some wireless devices to implicitly convey the current whereabouts of their user which makes it possible to make location-aware offers to mobile consumers. This also gives rise to more prominent privacy concerns than those experienced by consumers of wired e-Commerce.

- **Development Languages & Communication Protocols:** Most people are familiar with the Hyper Text Markup Language (HTML), the language that runs the wired Web. Mobile devices, however, are running on one of two variations of HTML: Wireless Markup Language (WML) or compact HTML (cHTML). WML is used in most parts of the world, whereas cHTML is used by DoCoMo in Japan with plans for expansion. The need for WML and cHTML is due to mobile devices having to comply with new communication protocols (e.g. the Wireless Application Protocol (WAP) and DoCoMo's (Japan) proprietary protocol i-Mode). Different from the wired Web's Hyper Text Transfer Protocol (HTTP), these new protocols present issues of compatibility and functional limitation.

- **Enabling Technologies:** Functional limitations arise in the m-Commerce environment as many of the existing technologies that enable e-Commerce on the Web with relative ease (e.g. cookies, JAVA, Active Server Pages, etc.) are not compatible with WAP, for example. Although new standards that would address these issues (i.e. WAP 2.0) are currently under development, however a tested and trustworthy system is still absent. This is not to say that business applications are not feasible at this stage, but that they are rather limited – for example, the lack of cookies in the wireless environment dampens marketing efforts, since the tracking of customer usage and online behaviour is not possible. In addition, mobile devices have a limited display area, processor memory and speed. Hence, the user experience is very limited and usage becomes cumbersome, as it is limited to text and small images, with little or no animation, almost no interactivity, and very few navigational options. Consequently, hopes and efforts are being placed on voice-enabling technologies that could combat these challenges, but these technologies are not widely adopted yet.

1.2 m-Commerce Technology

Understanding how the m-Commerce environment has come to exist, as we know it today, as well as recognizing the strengths and weaknesses of the associated technologies in place, can provide the means through which the long-term direction of this industry could be assessed. Thus, the current state of wireless networks, wireless protocols and wireless devices is discussed below, highlighting important milestones.

Wireless Networks

Wireless networks provide the backbone of m-Commerce activities. By utilizing these networks users can transmit data between mobile and other computing devices using wireless adapters without requiring a wired connection. Wireless networks were introduced as early as 1946, but a major milestone was the introduction of the Advanced Mobile Phone System (AMPS) that marked the arrival of cellular systems in 1983 in the United States. AMPS was an analog system used for voice communication [4]. AMPS systems represented the first generation of cellular systems (hence it is commonly referred to as 1G).

The evolution of wireless networks continued with the second-generation (2G) systems that were introduced in the 1990s. Several of these systems (e.g. TDMA, CDMA, GSM)[1] were also used primarily for voice applications, with the exception of the Short Message Service (SMS) capability offered by the GSM network. A recent upgrade of the 2G networks is referred to as 2.5G wireless networks (e.g. HSCSD, GPRS, EDGE)[2]. Being either circuit-switched or packet-switched, these networks are primarily intended to allow for increases in data transmission rates and, in the case of packet-switched networks, an "always on" connection [5].

The hype surrounding wireless networks, however, revolves around the third-generation (3G) systems, expected to be deployed over the next few years, with certain regions already having access to them (e.g. Japan). These networks are commonly referred to as IMT-2000 on a global scale, and regional implementations are uniquely named (e.g. CDMA2000 in North America, W-CDMA/ UMTS in Europe & Japan, cdmaOne in Japan).[3] Along with voice functionality, 3G networks support higher-speed transmissions for high-quality audio and video, as well as providing a global "always on" roaming capability [5].

Table 1 shows which wireless network technologies are currently in use for the regions of North America, Europe, and Japan [5]. It also outlines what kinds of technologies are soon to be rolled out in these regions.

Table 1: Wireless Networks' Technologies: Current & Future[4]

Region	Current Network (2/2.5G)	Future Network (2.5/3G)
US	TDMA, D-AMPS, CDMA, GSM, Mobitex, CDPD	CDMA2000 (2003)
Europe	Mobitex, GSM, HSCSD, GPRS	EDGE, W-CDMA (2002)
Japan	cdmaOne, PDC, W-CDMA	cdmaOne 3G (2002)

[1] TDMA: Time Division Multiple Access, CDMA: Code Division Multiple Access, GSM: Global System for Mobile Communications.
[2] HSCSD: High-Speed Circuit-Switched Data, GPRS: General Packet Radio Services, EDGE: Enhanced Data GSM Environment.
[3] W-CDMA: Wideband CDMA, UMTS: Universal Mobile Telephony System.
[4] D-AMPS: Digital-AMPS, CDPD: Cellular Digital Packet Data, PDC: Personal Digital Cellular.

The following diagram illustrates the overall path to the anticipated ubiquitous 3G environment [6].

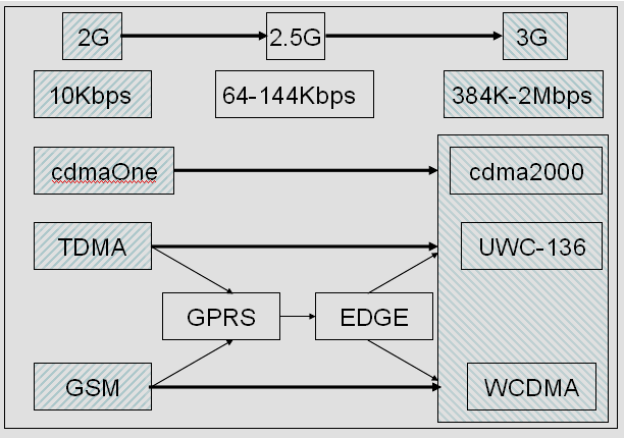

Figure 1: Evolution of wireless networks

Wireless Protocols

While wireless networks evolved, the two main communication protocols, WAP and i-Mode, experienced their own evolution. Phone.com, Ericsson, Motorola and Nokia introduced WAP in 1997. WAP progressed from enabling basic functionality, such as WML and WMLScript communications, in its first release, to supporting graphics, voice-enabled actions (i.e. wireless Web browsing), and video, as announced in the release of WAP 2.0, at the end of July of 2001 [7]. i-Mode, on the other hand, was introduced in 1999 by NTT DoCoMo and has grown in popularity to support 30 million users in less than three years. The capabilities of i-Mode were enhanced during 2001 through the introduction of i-appli which incorporates JAVA and Secure Socket Layer (SSL) encryption capabilities, i-area which provides location-specific information such as weather, local guide, maps and traffic, and i-motion which enables viewing of video-clips [8].

It is unlikely that one of these protocols will prevail over the other on a global basis. The more likely scenario will be that wireless devices will evolve to support both protocols seamlessly.

Wireless Devices

Until recently, wireless devices could be placed in three distinct categories: mobile phones, wireless Personal Digital Assistants (PDAs), and wireless laptops. Recently, however, hybrid products have been introduced that combine features from two or all three categories with the intent of providing optimal capabilities to mobile users.

Mobile phones have been around the longest and have experienced the greatest change since their inception. In the beginning, analog cellular phones were used exclusively for voice communications; next, digital phones were introduced, initially for voice communications but with added features (e.g. Call Display) and were later further enhanced with additional capabilities (e.g. Instant Messaging and Internet access).

PDAs experienced their own evolution, beginning as organizers for personal information with limited functions (e.g. "To Do" lists, Calendar). Currently, some PDAs have wireless transmission and Web browsing capabilities. The major operating systems for PDAs are Palm OS (e.g. Palm, IBM WorkPad PC, Handspring Visor), EPOC (e.g. Ericsson R380, Nokia 9210 Communicator, Psion) , and Windows CE (Compaq iPac, HP Jornada, Casio E-125).

Wireless laptops include notebooks or portable PC browser clients that are wirelessly Web-enabled (e.g. IBM ThinkPad T20 connected with a GSM mobile phone through the infrared port). Although these devices are capable of supporting m-Commerce activities, they do not represent the main point of access for such activities due to their relatively larger sizes and heavier weights compared to other mobile devices [5].

The most recent development in mobile devices was the introduction of "smart phones". These are mobile devices that are capable of tasks ranging from e-mail retrieval now to video and music streaming in the near future. "Smart Phones" are a combination of cell phones and PDAs (e.g. Kyocera QCP™ 6035 Smart Phone, Samsung SPH - I300) [9]. This convergence trend is expected to continue in the foreseeable future to support consumer demands for mobile devices that can provide a wider range of capabilities [10].

1.3 m-Commerce Market Overview

The growing importance of m-Commerce is fueled by the phenomenal growth in the wireless market in general. Figure 2 shows how the relative adoption rate of wireless services exceeds that of previous major technologies [11]. According to some forecasts, the global customer base for wireless Internet access is expected to match the overall wireless subscriber base by 2004 (over 1.2 billion subscribers, or 20% of the world's population) [12]; this represents the number of users who have access to the wireless Internet, but may not necessarily be using it.

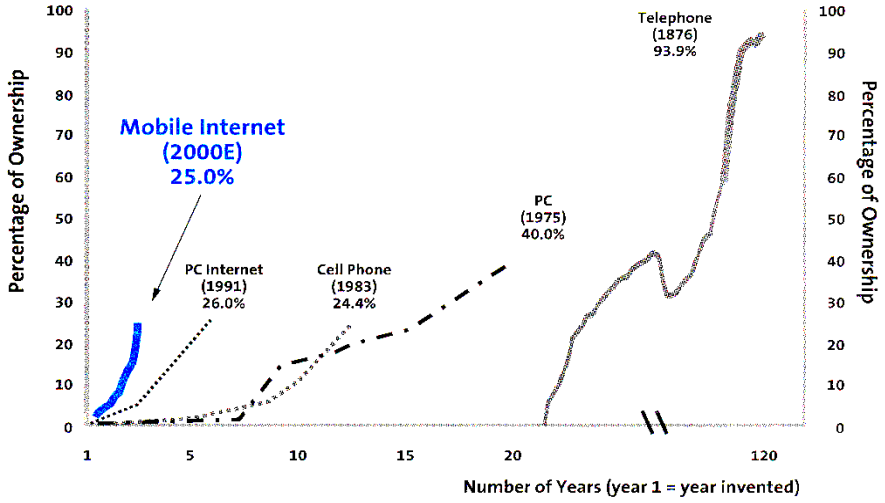

Figure 2: US adoption rates for various communication and Internet access devices [11]

This growth in wireless Internet subscribers is expected to be matched by a growth in m-Commerce related activities that vary by region, as indicated in Table 2, which outlines forecasted regional m-Commerce revenues. These revenue estimates by Jupiter are on the conservative side at $22.2 billion, compared to other research groups that predict m-Commerce revenues to be larger by as much as five times [13]. As such, m-Commerce represents a market with substantial financial returns, along with additional benefits, such as improved branding and customer service through the exploitation of the fast growing wireless channel. According to Table 2, the fastest growing and largest markets for m-Commerce are found in Asia, and in particular in Japan, followed by Europe.

Table 2: Regional m-Commerce Revenue (USD billion) [13]

Region	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
N. America	0.01	0.1	0.2	0.7	1.8	3.5
W. Europe	0.015	0.1	0.5	1.7	4.6	7.8
Asia	0.4	1.3	2.6	5.0	7.4	9.4
S. America	0.0	0.0	0.0	0.1	0.2	0.5
Other	0.0	0.0	0.1	0.2	0.4	1.0
Global	**0.425**	**1.5**	**3.4**	**7.6**	**14.5**	**22.2**
US	0.01	0.1	0.2	0.6	1.7	3.3
Japan	0.4	1.2	2.1	3.5	4.5	5.5

2. An m-Commerce Interaction Framework for Consumers

In this section, we present a framework that helps define the value proposition to m-Consumers. The first step in the process of crafting this value proposition is to identify the m-Consumer interaction modes within a wireless environment. By reflecting on the m-Consumer's possible activities, one could identify the following entities with which interaction may be required or desired to various degrees:

- Businesses – involving a Wireless Business-to-Consumer (W_{B2C}) interaction mode. It is important to note that most such interactions would naturally involve a Wireless Consumer-to-Business (W_{C2B}) interaction mode as well.
- Consumers – Involving a Wireless Consumer-to-Consumer (W_{C2C}) mode of interaction.

- Private networks – Involving a Wireless Consumer-to-self (W_C^2) interaction mode.

These entities and interaction modes are illustrated in Figure 3, where the entities are shown in rectangular boxes, examples of these entities are shown in ellipses, and the arrows indicate the direction of the interaction (i.e. who initiated the action). Some interactions, shown by single-directed arrows, are performed solely by one entity, and do not necessarily receive a response by other entities (e.g. stock alerts). Other interactions, shown by double-directed arrows, require the active involvement of both parties in a mobile transaction (e.g. mobile retailing or m-Tailing). Any of the above types of mobile transactions require at least one entity to be using the wireless channel and may involve some wired participants. Finally, network operators are included in this framework, but are not linked, because they provide the necessary infrastructure for these relationships to take place, or act as facilitators for supporting m-Commerce related activities.

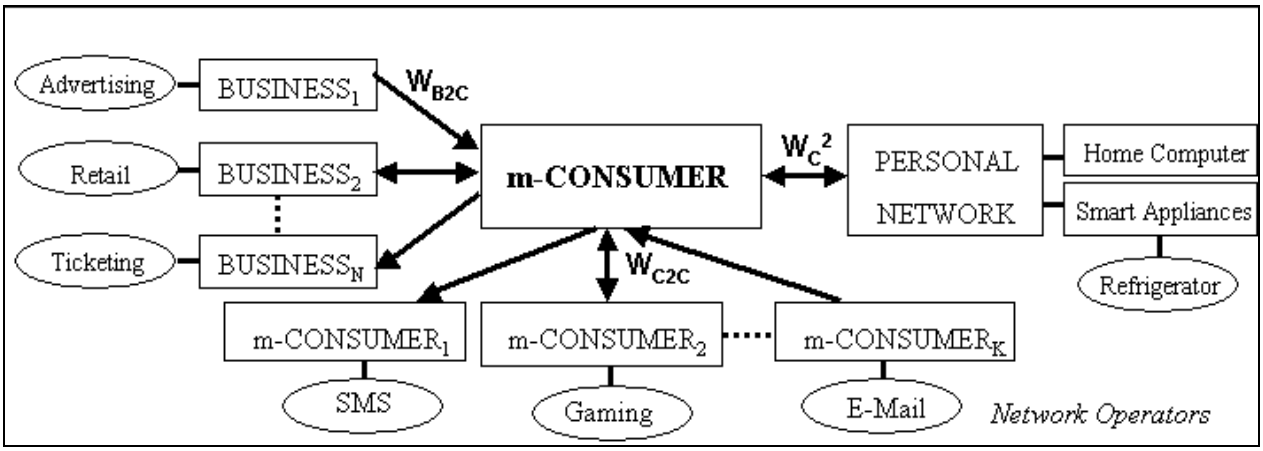

Figure 3: Interaction framework for the m-Commerce consumer

Businesses refer to individuals or organizations that a consumer may need or want to interact with wirelessly for business-related purposes. In addition, consumers may be at the receiving end of an interaction initiated by businesses. For the purposes of this paper, $\mathbf{W_{B2C}}$ is used to refer to this type of interaction, without paying attention to which party initiated the interaction.

Some examples of business applications in this area include retail, and advertizing offers directed at mobile consumers (m-Consumers).

m-Consumers refer to individuals that a consumer may need or want to interact with wirelessly for personal purposes. Some examples of this $\mathbf{W_{C2C}}$ type of interaction include communications (e.g. SMS or e-mail) and entertainment (e.g. gaming in a multi-player format).

Personal network refers to the server that a consumer owns and may need or want to access wirelessly for personal purposes. This type of interaction is identified through the notation $\mathbf{W_C^2}$. Examples of this type of interaction include a mobile user engaged in wireless communications with her/his home computer and its network, as well as any smart appliances, which may be connected to that network (e.g. a refrigerator).

3. The m-Consumer Needs & Concerns

There are five primary needs that yield demand for m-Commerce services. These are: connectivity, communication, information, entertainment, and commerce [14]. These five needs stem from the mobility associated with the enabling devices, so the context for each of them revolves around the theme of "anytime, anywhere" accessibility. These needs are outlined in Figure 4, which also shows the relationships among these needs. Thus, connectivity is the main need, because it provides the basic platform where wireless communications could take place, and communication in various forms is required to address the information, commerce and entertainment need areas. Consequently, concerns surrounding connectivity and communication are also likely to affect the remaining

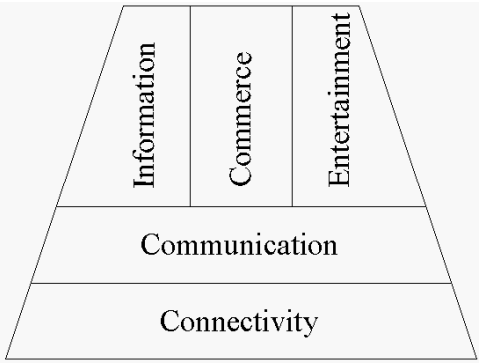

Figure 4: m-Consumer needs

consumer needs. All five needs are discussed in more detail below along with associated consumer concerns.

3.1 Connectivity Needs

Connectivity refers to having access to wireless networks including voice and Internet communications anytime and anywhere through various mobile devices. True connectivity is achieved through having access to ubiquitous mobile services. Ubiquity is not a trivial issue given the differences that exist in the wireless standards currently adopted in various parts of the world [15]. As indicated earlier, connectivity is the underlying requirement for mobile commerce and its applications.

Concerns

Consumer concerns surrounding connectivity involve the issues of security, reliability, download times, and cost, which are discussed below [16].

Security: Consumer fears regarding the safety of the information exchanged over a wireless network increases with the degree of interaction and the sensitivity of the information exchanged. Applications that require less interaction and are less personal (e.g. weather notifications) present a lower security concern than those applications involving increased interaction and containing personal information (e.g. mobile banking). Therefore, appropriate security features need to be implemented for each type of mobile application [17].

Reliability: For any extent of network coverage, it is important that the connection quality be maintained. The inherent concern here is that loss of the connection can result in loss of data [16]. This loss of data can yield anything from a simple interruption of Web surfing to loss of critical information used in financial transactions. The total cost for unreliable connections could be high, as it would encompass business losses and legal charges, including fees and fines.

Download times: Mobile users should not be forced to spend excessive amounts of time to access desired content [14]. Internet users have been accustomed to wired Web transfer rates of 55.6Kb/s through dial-up connections, as well as an increasing customer base for high-speed connections of up to 300Kb/s. These speeds serve the purpose of accessing rich content in a reasonable amount of time (i.e. up to 10 seconds) [18].

Due to the above perceptions, users expect similar services from a wireless device. Since, the transfer rates for most wireless devices are currently 9.6Kb/s, wireless Web content has to be trimmed down from design elements, such as graphics and animations, to deliver the requested information in similar times. In the wireless arena, it is even more important to provide fast download rates, as users are being billed for air-time either through a flat rate for a pre-specified limited number of minutes per month or by the minute. This is in contrast to the unlimited access models available for wired Internet connections.

Cost: Concerns in this area stem from the same experiences that came to influence user expectations of download times. In the case of wired Internet access, users now have the option of subscribing to different transfer rates, which come at different cost levels, subject to their individual needs. High-speed connections were introduced, while dial-up services were still maintained, thus satisfying a broader audience. Transferring this lesson to wireless networks, mobile carriers offering Internet access should rethink pricing options and strategies to successfully attract and retain a wider range of mobile customers. It is important to note that this cost concern impacts all other mobile consumer needs as well. Various pricing models are discussed in Section 5 of this paper.

3.2 Communication Needs

Once a connection is established, the fundamental need for a given mobile user is communication. Communication with others may be for business purposes, or for personal purposes (i.e. with other consumers or personal networks – refer to Figure 3), and may be carried out within an information, entertainment, or commerce context. Means by which an m-Consumer might choose to communicate include voice, text (e-mail, SMS), video, and data transfer.

Fulfillment of the need for communication presents industry with an opportunity to develop additional functions for mobile devices. For example, the European market capitalized on the penetration of cellular phones by extending the phone's capabilities, to include features such as SMS. In North America PDAs are the driving force behind m-Commerce and they seem to be converging in functionality with cell phones by offering modules for voice and/or video communication [10].

Concerns

The benefit of being reached anywhere anytime may take its toll on users, as they run the risk of being the victims of SMS spam, or even voice messages and phone calls placed by advertisers [19]. Although some abuse is expected to occur in this area, eventually these privacy-related issues would be minimized through customer reaction, carrier influence and possibly enforcement (i.e. legislation, consumer groups, network carrier policies, etc.).

Another type of privacy concern for consumers in this area is that their location might be revealed to interested businesses at all times. Knowing the whereabouts of each mobile user may be perceived as threatening, as this information could be dangerous if intercepted. Examples of such fears include:

- Knowing where mobile users are makes it easier for them to become victims of attacks.
- Knowing that the residents of a home are away makes their residence vulnerable.
- Location-based advertising that targets consumers based on their geographic location.

Aside from privacy issues, mobile users are concerned with how much it would cost them to communicate using any of the various communication methods identified above.

3.3 Information Needs

Similar to the explosion of demand for information through the wired Web, m-Consumers will increasingly start demanding information through mobile devices. This information may be similar to the general information found on the wired Web and can be categorized as being static or dynamic. Examples for these two categories would include a yellow pages-type directory (static) and cross-referencing of wireless websites for prices or specifications of a particular product (dynamic). In addition, mobile users will have access to location-specific information (e.g. finding a nearby restaurant based on the user's search criteria and current location). General information is already available for mobile users and will continually increase. Mobile-specific content is related to the growth of location-based services.

Concerns

A wide array of concerns exists in this area, including ubiquity, usability, privacy, cost, timeliness, freshness, and accuracy of information. Ubiquity, discussed under connectivity, is important, as mobile users should be able to access information irrespective of their location and device/network type. Extending from this concern for complete access to information, "walled gardens" (i.e. where content is limited to that provided by the user's network carrier), are viewed negatively by consumers, who want to have access to all available wireless content. Further, information should suit not only people's needs, but also the medium and the environment. For instance, content needs to be re-purposed for mobile devices, so that users can access easy-to-

digest pieces of news, not replicated long articles from the wired web [20]. One way to deal with the problem of excess information is to make it partially available online through the wireless Web and allow users to point to their personal wired servers as a destination for saving big files for later examination, thus incurring no heavy airtime costs and freeing up their time by not forcing them to perform solely that single task. This notion ties in with usability, which raises the questions of how easy it is for the mobile user to access the information sought and what the quality of the overall experience is. Adherence to website design guidelines specified through research findings, along with use of available Web analytics tools, can help address this area of concern.

Privacy, in the information context, refers to a user's fear of other people/organizations knowing what s/he is interested in ("Big Brother syndrome"). Tracking user Internet-browsing behaviour and information requests on the wireless Web is a sensitive topic as it is for its wired counterpart. The ability to know the exact location of a user at all times further escalates the sensitivity of the Big Brother syndrome.

Cost refers to the pricing concern for the accessed information – how much, who and how does someone pay for the information they access. Timeliness and freshness of the information highlight the importance of having informative content as it unfolds in near real-time (timely) and remains up-to-date as long as it remains published on the wireless Web (freshness). Finally, accuracy combined with timeliness and freshness will positively impact consumer trust in the quality of presented information.

3.4 Entertainment Needs

Is "killing time" the "killer application"? Perhaps, but even if it doesn't have the impact that e-mail had for the wired Web, it is getting a lot of attention by the mobile industry, due to high

user demand [21]. In general, users want to turn to their mobile devices when they have a few minutes to kill and get useful and practical entertainment solutions, such as access to games or leisurely information. However, in some contexts (subject to culture and availability of entertainment alternatives) mobile devices may act as a primary source of entertainment.

Concerns:

Mobile entertainment concerns revolve around connectivity, cost (pricing schemes for accessing this service/application) and usability. Connectivity concerns were already discussed above. Usability issues are subject to the nature of the application and to the specifics of the mobile device being used, but the following points can act as guidelines:

- Games should be either small enough in size to store on the mobile device or to download as needed. These games should also be re-configurable for different mobile devices.
- Ring tones, graphics, and other recreational elements, should also have low resource requirements (i.e. file size, audio and video requirements, memory, etc.).

Finally, cost concerns arise regarding how much, and how does someone pay for the mobile entertainment service he/she receives.

3.5 Commerce Needs

Two main elements are required to enable mobile consumers to conduct m-Commerce transactions: presentation of product/service information (as discussed in Subsection 3.3) and a wireless payment mechanism. The value in consumers making payments wirelessly arises from the convenience it offers. For example, mobile users might not require coins/bills to make certain physical purchases (e.g. from vending machines), digital purchases (e.g. purchases on a wireless website), or even bill payments (e.g. Mobile Bill Presentment and Payment). Although several approaches for payment exist for mobile payments, three main options are predominant. These options are explained below:

- "Pre-pay" involves a physical/electronic deposit by the user to receive "credits" on her/his mobile device (i.e. smart card). These deposited funds could subsequently be used during wireless payment transactions [22].
- The mobile user's bank account information is stored (either within the mobile device or in the service provider's database) and the specifics are transferred during the transaction, so that the merchant can automatically debit the user's account to collect payment [23].
- The total cost of purchases is tracked by the wireless network carrier and presented on the monthly statement for the wireless service [24] (i.e. similar to the credit card model).

The option that is becoming increasingly popular is pre-pay [25], and along with mobile retailing, or m-tailing, presents new opportunities in shopping. Whether pre-pay serves as a primary method of paying, or acts merely as a back up method, the option is there for users to pay for bills (e.g. utilities, purchases, etc.) with their mobile devices, allowing for improved flexibility and convenience.

Concerns:

Although the mobile payment option is available, companies should be aware that consumers are not likely to purchase tactile goods or very expensive items online, let alone on their mobile devices. This lesson was learned from the e-tailing (electronic retailing) experience where consumers were highly interested in conducting pre-purchase research for expensive goods online but rather apprehensive about actually making such purchases remotely. m-Consumers are expected to exhibit the same type of behaviour and be reluctant to perform such purchases on their mobile devices. It is expected that m-Consumers will even hold back on conducting pre-purchase research on their mobile devices due to the costs involved as well as the limitations associated with such devices currently. m-Commerce, instead, appears to have already gained users' buy-in in Europe for purchasing small items, such as beverages from vending machines [14].

In addition, security concerns exist, because of the minimal security mechanisms in place for the millions of mobile devices. Security will become an increasingly important issue, as device

capability and data sharing increase [26]. This concern is complemented with concerns regarding the privacy of personal information that is required during payment transactions.

4. m-Commerce Consumer Business Applications

This section will review various business applications targeting the mobile consumer and discuss how they address the inter-dependence of the three areas already discussed in this paper (i.e. wireless technology, m-Consumer interaction, m-Consumer needs/concerns); this discussion is summarized in Table 3. The characteristics identified for each business application, in the table, include the following:

- Consumer needs addressed by the business application.
- Interaction modes covered by the business application (referring back to Figure 3).
- Global market size (in users), unless otherwise noted, for the business application, if available.
- Perceived value and willingness to pay for the business application.
- Concerns associated with the business application.
- Technology requirements for the business application.

The applications presented in the table are those of highest interest to consumers, according to research [17], and they often address multiple needs. For example, mobile banking would include options to access a user's account to obtain a balance, transfer funds, and even proceed with trading securities. This application, therefore, satisfies both the need to access information, as well as, engage in commercial transactions. In general, applications have been grouped under a need area in the first column of Table 3; according to which need they predominantly cater to.

Communication Applications

By examining the needs satisfied through the communication applications, it becomes apparent why satisfying the need for communication represents the foundation for satisfying all the remaining m-Consumer needs, as shown in Figure 4. From the "Interaction Mode" column in Table 3 it is evident that only communication applications target all of the different consumer

Table 3: Characteristics of m-Commerce Consumer Business Applications

Business Application	Needs[5] 1	2	3	4	Interaction Mode	User market in millions, 2005 [9]	Value	Concerns	Technology Requirements[8]
Communication									
- Voice	√	√	√	√	W_{B2C} W_{C2C}	1268	Highest	Cost, Privacy	**1G** / 2.5G, Voice module
- SMS	√	√	√	√	W_{B2C} W_{C2C}	1268	Highest	Cost	**2G** / 2.5G, WAP 2.0
- e-Mail	√	√	√	√	W_{B2C} W_{C2C}	200[A] (by 2004)	Highest	Cost	**2G** / 2.5G, WAP 2.0
- Data Transfer	√	√	√	√	W_{B2C} W_{C2C} W_C[2]	2.8 (residential) 9.5 (Total)	Highest	Cost	2.5G / 3G
Information									
- Web browsing	√	√	√	√	W_{B2C}	614	Highest	Cost, Usability	**2G** / 2.5G / 3G, WAP 2.0
- Traffic/Weather		√			W_{B2C}	N/A[6]	Highest	Privacy, Usability	**2G** / 2.5G, LBS[7]
Entertainment						775 (Total)			
- Gaming			√	√	W_{B2C} W_{C2C}	200 [B]	Highest	Cost, Usability	**2G** / 2.5G / 3G, WAP 2.0
- News/Sports		√	√	√	W_{B2C}	N/A	High	Cost, Usability, Privacy	**2G** / 2.5G
- Downloading Music/Video/Img.			√	√	W_{B2C}	N/A	Medium	Download times, Cost	2.5G / 3G, WAP 2.0
- Horoscope/ Lottery		√	√	√	W_{B2C}	N/A	Low	Cost, Privacy	**2G**
Commerce									
- Ticketing (e.g. Event, Cinema)		√		√	W_{B2C}	N/A	Highest	Cost, Usability, Security, Privacy	**2G** / 2.5G
- Pre-Payment				√	W_{B2C}	18.3 (by 2003)	Highest	Security	**2G** / 2.5G, Real-time Billing
- Banking		√		√	W_{B2C}	798	High	Security, Privacy	**2G** / 2.5G
- Advertising		√		√	W_{B2C}	$16-23 billion	Medium	Privacy (Spam)	2.5G/3G, LBS, WAP 2.0
- Retailing		√		√	W_{B2C}	469	Medium	Security, Privacy, Usability	2.5G / 3G, LBS, WAP 2.0

[5] 1. Communication, 2. Information, 3. Entertainment, 4. Commerce
[6] N/A = Not Available, [7] LBS = Location-Based Service
[8] Available technology is in bold, while future technology is shown in normal font (note: 2.5 G is available, but not widely used yet)
[9] Source: allNetDevices, http://www.canvasdreams.com/viewarticle.cfmarticleid=941, except A=ARC Group 1999, http://www.epsltd.com/IndustryInfo/Statistics/mobilestats.htm, & B=Datamonitor 2000, http://cyberatlas.internet.com/markets/wireless/article/0,,10094_455141,00.html

interaction modes. As such, these applications can cater to a wider audience, who appear to be more interested in and more willing to pay for this type of applications.

Cost appears to be the primary concern and would thus require network carriers to revisit their pricing models. Finally, with respect to technology, only "data transfer" is affected by the slow adoption of 2.5G, since voice, SMS, and e-mail can operate efficiently within existing technologies. Future enhancements exist in VoiceXML, the technology that will enable voice-driven applications, some of which is already available (e.g. speaking out the name of the person whose phone number is to be dialed). Enhancements are also expected in 3G networks and the WAP 2.0 protocol which will support rich content in SMS and e-mail communications, as well as providing for higher transfer rates for data transfers.

Information Applications

These applications target the wireless B2C consumer interaction mode. A high consumer interest in these wireless information websites, suggests the opportunity for content providers to start charging mobile consumers for their services, if they are not doing so already (e.g. subscription, utility, etc.).

Cost and usability take front stage in terms of mobile consumer concerns, and along with network carriers and content providers rethinking their pricing models, content providers need to ensure a high level of usability to avoid customer dissatisfaction and potentially market attrition.

Finally, 2.5G and 3G network technologies will help improve the wireless Web experience, and the available information could become rich in form, yielding higher customer appreciation and interest. In addition, future location-based services could enable dynamic searching and comparison for location-specific information.

Entertainment Applications

Entertainment can involve various activities, some of which can satisfy various types of mobile consumer needs. Gaming appears to be currently the hottest segment, with emphasis on the teenage and young adult community [27]. Until recently, however, this offering was limited due to protocol constraints (WAP did not allow for graphics and rich content). The next generation of protocols should be able to address this problem. As usual, cost and usability are in the foreground as concerns, along with download times. A mobile user may seek entertainment for a short interval on a spontaneous basis. Therefore, excessive download times will not be well received. Finally, 2.5G and 3G network technologies, along with the introduction of WAP 2.0 will help improve not only the gaming experience, but also other entertainment-related applications.

Commerce Applications

Although gaming appears to be the short-term cash cow for m-Commerce, mobile banking presents the primary application for generating the much-needed critical mass in the near future, which in turn can yield significant revenues. In addition, banking is an application that is not a passing fad and subject to the latest video and audio technologies, rather it is an important provision for mobile consumers and their needs to save time from routine activities, such as going to the bank to pay a bill. Mobile banking is a key application for supporting the mobile payment mechanisms needed for other m-Commerce applications to take place.

Cost and usability are present concerns once again, but due to the sensitive nature of the information exchanged in a commercial transaction, security and privacy concerns prevail. The limitation in addressing these concerns effectively today lies in the existing infrastructure. Existing wireless networks and protocols can provide basic security, but frequently security

features are sidestepped in return for time benefits (mobile users omit/deactivate security features to save on transmission time). Therefore, until upgraded networks and protocols supporting enhanced security are in place, mobile users may be reluctant to take advantage of these applications. Finally, m-Commerce industry players need to implement sufficient content to serve as incentive for not only converting consumers to mobile users, but also to retain these mobile users for the long run.

5. Discussion & Conclusion

The m-Commerce industry is fast growing with estimates of reaching a user base of 1.3 billion people around the world by 2005 which will contribute to an overall market in excess of USD$22 billion. Industry players, ranging from network carriers to content providers hope to capture part of this revenue. However, early results were not up to the hyped expectations, due to a combination of reasons covered in this paper as technology limitations or concerns to the various business applications outlined in Section 4. These concerns center on the issues of cost, speed, usability, security, and privacy. For m-Commerce to take off, all of these concerns will have to be effectively addressed. It should also be noted that health concerns, although not linked to any particular application, pose another barrier for adoption of wireless technology. On this issue, the m-Commerce industry will need to clearly communicate any findings, so as to reduce fears of health hazards consequent of mobile device usage.

For the most part, the drawbacks found in using mobile devices for Web-based functions will be resolved in the near future; as advancements are being made simultaneously in wireless networks, wireless protocols, mobile devices, and supporting technologies. One area that deserves particular attention is related to content management. Issues in this area arise from the lack of compatibility and the absence of automated translation mechanisms between the wired

and wireless Web environment. It may be the case that before long language interpreters or translators will convert a single website to any standard, taking into consideration the form factor involved. For now, these applications are emerging, and organizations are required to go through the nuisance of running two separate sites (i.e. one for the wired Web and one for the wireless Web) and manage the associated complexities. Consequently, additional resources are required which are estimated at 30 percent over and above the cost of implementing an HTML Web site [2].

Once technology-related problems are addressed effectively, the emphasis for market players will shift to developing content and implementing effective m-Commerce business models. Understanding what the m-Consumer needs and wants are, as outlined in this paper, can facilitate the creation of a loyal m-Consumer base. Businesses targeting m-Consumers need to understand that a Web-enabled mobile device does not necessarily guarantee a user who will take advantage of this capability. Currently, the success story for m-Commerce lies in the Far East, where Japan has successfully captured 30 million users in less than three years on their i-Mode platform. The reason for this success is largely due to the content that was made available early on, an element that was not present for WAP users in other regions [28]. Development language and protocol limitations were partly responsible for this situation, but with WAP 2.0 addressing most of these concerns, content providers need to take charge and give users something to go mobile for, other than communicating. "Content is king" may be an old cliché, but it holds true for this phase of m-Commerce, where users do not see a limitation of devices, but rather one of content, and are therefore reluctant to make the transition to the wireless Web.

As apparent from the discussion in Sections 3 and 4, cost appears to be a major concern for most m-Consumers' needs and their corresponding business applications. Who will pay for

content is a question that will draw a lot of attention and will require the cooperation of both network operators and content providers. For the time being, m-Consumers are mostly concerned with connectivity and communication costs. Currently, there are three prevailing billing options for these services [29]:

- Flat Rate: a nominal charge for unlimited access for a given length of time (e.g. month).
- Per Minute: charged for every minute connected to the network.
- Per Bit: charged for the total volume of data transferred in a given period of time.

Adopting a flat rate pricing model at this stage would be the best approach to lure new customers fast, which is necessary to provide the much needed critical mass to alleviate the development costs and in particular the high license fees for network carries engaged in implementing 3G network technology. The basis for this recommendation lies in the following two observations:

- First, users have been accustomed to flat-rate schemes (ISPs & cell phone providers).
- Second, users are in favour of flat-rate schemes, because of the model's simplicity and the ability to control expenses.

Once a critical mass has been established, different means for pricing may be adopted, and even a combination of models may become available for any particular region, subject to the m-Consumer's use of the wireless Web. At that point, pricing based on the data in/outflow, would be favored by wireless operators, because it would serve as an indirect control on the use of the networks and would help prevent network overload, a situation presently felt by many mobile phone subscribers.

Another dimension to the cost issue is who ends up paying for a wireless interaction in an m-Commerce transaction. In North America both the caller and the receiver of a wireless communication pay their providers for that interaction under current pricing schemes. This scheme represents a significant obstacle to the spread of m-Commerce, as consumers will resist having to pay for unsolicited offers received from businesses on their wireless devices. A pricing

model, in which the initiator of an m-Commerce interaction is responsible for footing the bill, would be a significant boost for the consumers' involvement in m-Commerce activities.

Finally, it is even conceivable, that the above models will eventually be replaced by a free, unlimited access, for the user, subject only to a rental cost for the device and using m-Commerce fees to offset the remaining costs. These fees may be derived from notification services (paid by user), advertising (paid by advertising company), transaction fees on mobile purchasing (paid by merchants, similar to Interac and credit cards), and further means yet to be identified, as the m-Commerce market evolves [30].

Future research in the area will be focused on issues related to devising m-Commerce business models that can take full advantage of the fast unfolding technological improvements in the areas of wireless networks, devices and protocols. Such models will have to pay close attention to satisfying the needs of m-Consumers while minimizing their concerns. Another area of key importance for future research in this field is the usability of both mobile devices and m-Commerce Websites since it is highly related to the rate of adoption of m-Commerce activities by m-Consumers.

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