Chapter VI

Understanding the Mobile Consumer

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ABSTRACT

The recent surge of interest in mobile commerce (m-commerce) is fueled by consumers' 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 all places. Businesses that aspire to succeed in this market must have a deep understanding of the interests and concerns of the mobile consumers in using wireless applications. With this in mind, this chapter provides an analysis of this emerging market from a consumer's perspective. A consumer-centric m-commerce model outlining the various wireless interaction modes of the mobile consumer (m-consumer) is presented, followed by a discussion of the needs and

concerns of the m-consumer. An m-commerce value network is then presented, outlining the roles of the different players within this industry. The various business applications developed to address m-consumer needs are then presented. Finally, a global m-commerce market overview is provided, and some future trends are outlined.

INTRODUCTION

From its inception and over the last two decades, the Internet has undergone significant change. It dramatically adapted to suit new network technologies and telecommunication services. The subsequent ability to engage in transactions for personal or professional use over the Internet has come to be known as electronic commerce or e-commerce. The most recent trend of e-commerce involves expanding the services offered and extending the reach to customers through powerful affordable computing and communications in portable forms (i.e., laptop computers, two-way pagers, PDAs, cellular phones). The mobility associated with these devices has resulted in naming this new trend mobile commerce or m-commerce (Leiner et al., 2002). 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 chapter starts by exploring the similarities and differences between m-commerce and e-commerce. In particular, contrasts will be made in the areas of communication modes, Internet access devices, development languages/communication protocols, and enabling technologies. A consumer-centric m-commerce model outlining the various wireless interaction modes of the mobile consumer (m-consumer) is then presented, followed by a discussion of the needs and concerns of the m-consumer. M-consumer needs are then matched with relevant concerns, and special emphasis is given to the important areas of cost, wireless security, and wireless privacy. An m-commerce value network is then presented, outlining the roles of the different players within this industry. The roles of the various players within the m-commerce value network in addressing the m-consumer concerns are then discussed. The various business applications developed to address m-consumer needs are then presented and classified according to the different need areas. We also summarize the current technologies in support of such applications, indicating any shortcomings of

such technologies that might stifle the consumer adoption rates of particular wireless business applications. Future technologies that could resolve such issues are also outlined. A global m-commerce market overview is provided. The chapter ends with a discussion and some future trends.

M-COMMERCE OVERVIEW

The name "m-commerce" arises from the mobile nature of the wireless environment that supports mobile electronic 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 (Little, 2001). Because m-commerce encompasses any electronic activity that utilizes wireless technology, it may be viewed as a subset of e-commerce. Furthermore, m-commerce and e-commerce share fundamental business principles, but m-commerce acts as another channel through which value can be added to e-commerce processes. It also provides for new ways through which evolving customer needs could potentially be met.

Contrasting M-Commerce and E-Commerce

The m-commerce and the e-commerce business environments and activities have much in common. This is the case, because they involve much of the same functionality in terms of facilitating electronic commerce 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 (Little, 2001).

- **Communication mode:** E-commerce is mainly conducted through a wired connection, while m-commerce mainly operates over wireless networks. This is a fundamental difference between the two environments, as m-commerce overcomes the barrier of a fixed location, and customers can engage in commercial activities anytime, anywhere using various forms of wireless communication devices.
- **Internet access devices:** While e-commerce is conducted mainly through wired desktop and laptop computers, m-commerce is conducted

through wireless devices (e.g., cell phones, PDAs, wireless-enabled laptops). Because wireless devices tend to be used by a single user who carries the device at most times (and because the location of the device can be tracked), there is enhanced opportunity to offer personalized products/services, albeit privacy concerns are escalated because of this tracking/personalizing ability.

- **Development languages and communication protocols:** Hypertext Markup Language (HTML) runs the Web on wired networks, whereas on wireless networks, wireless devices are running on one of two variations of HTML: Wireless Markup Language (WML) or compact HTML (cHTML). 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 i-mode®]. Different from the wired Web's Hypertext Transfer Protocol (HTTP), these new protocols present issues of compatibility and functional limitations.
- **Enabling technologies:** Several of the existing technologies that enable e-commerce with relative ease (e.g., persistent cookies, i.e., cookies that are stored between user sessions) are not currently supported over wireless networks and cannot be utilized by m-commerce.

M-Commerce Technology

As indicated in the previous section, the greatest difference between m-commerce and e-commerce lies with what and how technology is being used. In this section, three areas of technology that are fundamental for m-commerce will be examined in further detail: wireless networks, wireless protocols, and wireless devices.

Wireless Networks

Wireless networks provide the backbone of m-commerce activities. Users can transmit data over these networks between mobile and other computing devices through the use of wireless adapters without requiring a wired connection. The first 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. The AMPS is an analog system used for voice communication (3GAmericas, 2002). AMPSs represented the first generation of cellular systems (hence, it is commonly referred to as "1G").

Table 1: Wireless Networks' Technologies: Current and 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	W-CDMA, cdmaOne (2002)

The evolution of wireless networks continued with the implementation of 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 (Peck, 2001).

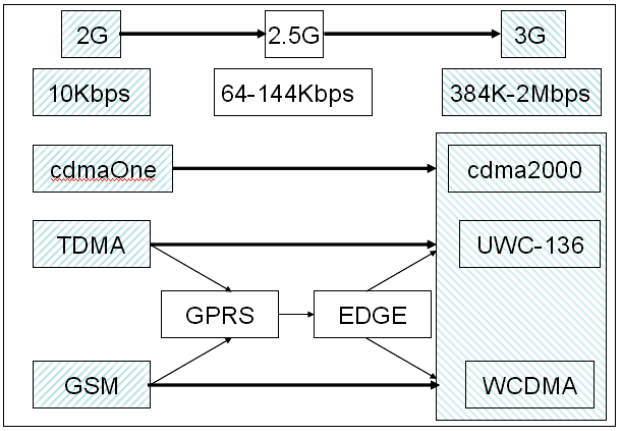
The hype surrounding wireless networks, however, revolves around the third-generation (3G) systems, expected to be deployed over the next few years, with certain regions already having access to them (e.g., Japan). These networks are commonly referred to as IMT-2000 on a global scale, and regional implementations are uniquely named (e.g., CDMA2000 in North America, W-CDMA/UMTS in Europe and Japan, cdmaOne in Japan).[3] Along with voice functionality, 3G networks support higher-speed transmissions for high-quality audio and video enabled through high-bandwidth data transfers, as well as provide a global "always-on" roaming capability (Peck, 2001).

Shown in Table 1 are wireless network technologies that are currently in use or are expected to be rolled out in the regions of North America, Europe, and Japan (Peck, 2001). In Figure 1, the path to the anticipated ubiquitous 3G environment is illustrated (ITU, 2001).

Wireless Protocols

While wireless networks evolved, the two main communication protocols, WAP and i-mode, experienced their own evolutions. Phone.com, Ericsson, Motorola, and Nokia introduced WAP in 1997. WAP progressed from enabling basic functionality, such as WML and WMLScript communications,

Figure 1: Evolution of Wireless Networks (Adapted from ITU, 2001)



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 2001 (WAP Forum, 2001). On the other hand, i-mode 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 the viewing of video clips (NTT, 2002).

Wireless Devices

Until recently, wireless devices could be placed in three distinct categories: wireless phones, wireless 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 enhanced capabilities to mobile users.

Mobile phones have been around the longest and have experienced the greatest changes 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).

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 (Peck, 2001).

The most recent development in mobile devices was the introduction of "smart phones." These are mobile devices 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) (Pocket, 2001).

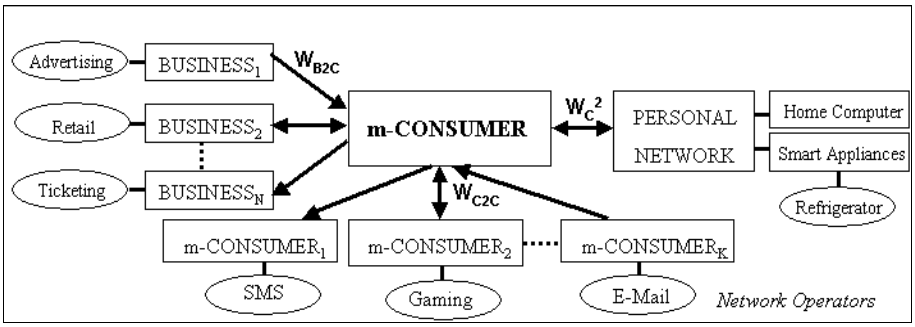
M-COMMERCE CONSUMER INTERACTIONS

To better understand the value proposition that m-commerce presents to consumers, it is important 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 2, where the entities are shown in rectangular boxes, examples of these entities are shown

Figure 2: A Consumer-Centric M-Commerce Model (Coursaris & Hassanein, 2002)



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 model 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.

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 chapter, $\mathbf{W}_{\mathbf{B2C}}$ 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 advertising offers directed at m-consumers. These applications are made available through the combined efforts of all members (excluding customers) of the value network to be introduced in the section "Addressing m-consumer concerns" (see Figure 3).

M-consumers refers to individuals that a consumer may need or want to interact with wirelessly for personal purposes. Some examples of this $\mathbf{W}_{\mathbf{C2C}}$ type of interaction include communications (e.g., SMS or e-mail) and entertainment (e.g., gaming in a multiplayer format).

Personal network refers to the server that a consumer owns and may 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 his or her home computer and its network, as well as any smart appliances that may be connected to that network (e.g., a refrigerator).

M-CONSUMER NEEDS

Five primary needs can be identified that yield demand for m-commerce services. 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 and the subsequent discussion may also apply to business customers to some degree, but specifics associated with the business segment are not explored in this chapter, as the focus is on the end consumer. These needs are as follows:

- **Connectivity needs:** Connectivity provides the basic platform on which wireless communications take place. In an ubiquitous wireless environment that overcomes geographic (i.e., location of the consumer) and compatibility (i.e., interoperability of networks) constraints, consumers become capable of true "anytime, anywhere" communications.
- **Communication needs:** M-consumers communicate with others for business or personal purposes (i.e., with other consumers or personal networks), and their communications may be carried out within information, entertainment, and commerce contexts.
- **Information needs:** M-consumers need access to information that may be static (e.g., Yellow Pages-type directory) or dynamic (e.g., cross-referencing of wireless Web sites for prices or specifications of a particular product). In addition, consumers may be interested in location-specific information (e.g., finding a restaurant based on the user's search criteria and current location).
- **Entertainment needs:** Wireless devices can provide users with practical entertainment solutions, such as access to games or leisure information.
- **Commerce needs:** Two main elements are required to enable m-consumers to conduct m-commerce transactions: presentation of product/service information 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 Web site), or even bill payments (e.g., Mobile Bill Presentment and Payment).

M-CONSUMER CONCERNS

A wide range of consumer concerns arise within the m-commerce environment. The main concerns are summarized below:

- **Privacy:** In the information context, privacy refers to a user's fear of other people/organizations knowing what he or she is interested in ("Big Brother syndrome"). Tracking user Internet-browsing behavior 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. 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 to the m-consumer, as this information could be dangerous if intercepted.
- **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. Security is a critical component in protecting consumer privacy.
- **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 (Nielsen, 2000).
- **Download times:** Mobile users should not be forced to spend excessive amounts of time to access desired content (Cole, 2001).
- **Cost:** Users of wired Internet access have the option of subscribing to different transfer rates, which come at different cost levels, subject to their individual needs. Aside from the cost of connecting to the wireless Web, there is also a cost concern for the accessed information.
- **Usability:** Information on the wireless Web should suit not only people's needs but also the medium and the environment. For instance, content needs to be repurposed for mobile devices, so that users can access easy-to-digest pieces of news, not replicated long articles from the wired Web

(McGinity, 2000). This notion ties in with usability, which raises the following questions: How easy is it for the mobile user to access the information sought? What is the quality of the overall experience? Factors influencing the quality of the overall experience include a user's ability to read the screen, input data, manipulate files, and access sites of interest.

- **Content:** Limited content availability is a consideration that prevents customers from accessing the Internet wirelessly. Further user frustration is experienced when they are victims of "walled gardens" (i.e., when they cannot access desired content because it is available only to users of other network carriers).

MATCHING M-COMMERCE NEEDS AND CONCERNS

The consumer concerns associated with m-commerce identified in the previous section may apply to more than one area of mobile applications. As Table 2 illustrates, the four m-commerce consumer application areas exhibit similar concerns, with cost, security, and privacy prevailing, as they are present as concerns in all application areas. By addressing these three concerns, businesses would reduce consumer reluctance to accept and adopt this new medium.

The Cost Concern

Who will pay for the content? This is a question that will draw a lot of attention and will require the cooperation of network operators and content providers. For the time being, m-consumers are mostly concerned with connectivity and communication costs. Currently, there are three prevailing pricing options for these services (McGinity, 2001):

- **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.

Table 2: M-Consumer Needs and Corresponding Concerns

Business Application	Concerns
Communication	Cost, Privacy, Security
Information	Cost, Usability, Privacy, Security
Entertainment	Cost, Usability, Privacy Download times, Cost, Privacy, Security
Commerce	Cost, Usability, Security, Privacy

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

Once a critical mass is 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 inflow and 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 consumer 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 (Simon, 2002).

The Security Concern

Wireless technology possesses two main vulnerability areas that are a hacker's main attack points. The first point is known as the "Two-Zone problem" or the "WAP Gap." The WAP architecture requires an intermediate gateway (WAP gateway) that encodes and decodes data from the wired encryption format known as SSL (Secure Socket Layer) to its wireless counterpart WTLS (Wireless Transport Layer Security). This process lasts briefly (milliseconds), but the data is unsecured in the interim, as it needs to be decrypted from WTLS into plain text and then reencrypted into SSL. The inherent risk is loss or exposure of data, if a hacker is able to extract the plain text (Gururajan, 2002).

The second point refers to the data stream that is carried through the air medium and is susceptible to "eavesdropping." The success of the hacker in such an attempt depends in part on the encryption algorithm used. The current standard employed by GSM is the A5 algorithm, which utilizes a 54-bit encryption, which is slightly better than the IEEE 802.11 standard RC4-40 algorithm (also known as WEP, or Wireless Equivalent Privacy) that only uses a 40-bit encryption. However, both are still not efficient to desired levels (Pesonen, 1999; Bask, 2001). When comparing this level of encryption to the respective levels of wired encryption at 128-bits, it becomes apparent how low the level of wireless security currently is, especially when one considers that hacking a 128-bit encrypted message is also feasible. In addition, implementing an effective encryption algorithm is further complicated due to the mobile device limitations that still prevail. Limited battery life, low processing memory, and even pricing methods (i.e., per-minute billing), act against the implementation of a 128-bit encryption algorithm in a wireless setting.

Aside from identifying the most likely points of a hack attack, it is important to address the loss or theft of a mobile device as a security issue, because the data stored in the device could be highly sensitive. To combat this situation,

mobile users should be empowered through added features for their mobile devices that would safeguard their privacy. These features may be invisible to the user (e.g., memory protection, file access control), or they may require interaction (e.g., log-in software, biometrics) (Gururajan, 2002; Johnson, 2002).

Finally, although security is not synonymous with privacy, it is a critical element in preserving identifiable information as private. As such, privacy concerns arise consequent of the lower security levels of wireless networks and of the potential for using tracking and profiling technologies to offer m-customers unsolicited location-based services, for example. These issues are explored next in some detail.

The Privacy Concern

Privacy concerns exhibited by m-consumers are similar those of e-commerce customers. In addition, new privacy concern elements arise consequent of the lower security levels of wireless networks and of the potential for using tracking and profiling technologies to offer m-customers unsolicited location-based services.

The vulnerability of wireless networks creates increased risk for privacy interruptions through potential network security breaches. The ability to snoop in on a user's conversation or even monitor data transmissions generates an uneasiness that the consumer may not be willing to accept. Enhanced security algorithms and hardware improvements can help minimize the risk of such violations.

Positioning services provide additional information companies could use to improve understanding of the mobile user. The ability, however, to know the exact whereabouts of a mobile user may be perceived as threatening by the consumer, as this information could be dangerous if intercepted. Examples of such fears include the following:

- Knowing where mobile users are makes it easier for them to become victims of physical 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 is unsolicited.

The last example, location-based advertising, is one of the most controversial aspects of the ability to track a mobile device and, hence, its user. Companies are using this ability to market their products and services more aggressively. These marketing efforts build on the consumer concern for cost, as they may come at a cost to the mobile user, who may possibly end up paying to read or listen to an incoming advertising message that may be in the form of an e-mail message, SMS, or a phone call.

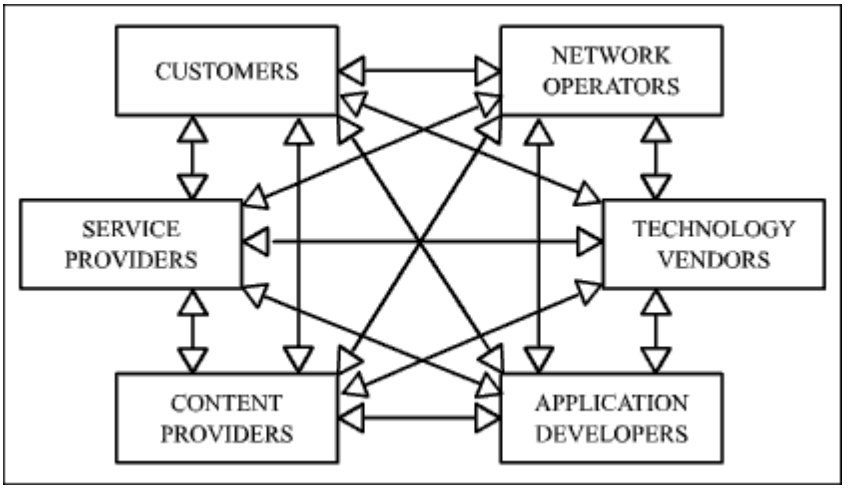
In effectively addressing the entire range of m-consumer concerns, the active participation of all m-commerce market players is required. The roles and responsibilities for each of these players are examined next.

ADDRESSING M-CONSUMER CONCERNS

Several companies positioned themselves to play a multifaceted role in this industry, thus creating an entirely new business landscape, where players often have overlapping roles. The mobile value chain becomes more intimate and dynamic, possibly with multiple interactions that do not necessarily preserve a sequential nature and where all market players need to contribute for the industry to reach an optimal level. Thus, a new m-commerce value network (Figure 3) was proposed by Coursaris and Hassanein (2002) that better captures the interactions between the various players in the industry. The mobile value network introduced is made up of customers, network operators, service providers, technology vendors, application developers, and content providers. Because of the multiple interdependencies among value network members, if any of these parties is underdeveloped (or even absent), then the entire network could potentially break down. In addition, each of the six parties identified in this new value network may be made up of additional subsets of companies with more specific business objectives; these possible subsets are identified next, where each value network member is discussed in further detail (Turban, 2002; Kalluvilayil, 2001; Kalakota, 2002; Buckingham, 2000):

- **Customers:** Customers may be the most important value network member, because in the absence of customer demand, there may be little, if any, need for any of the other players in the value network to be present. For example, if the wireless customer does not see the value in nonvoice mobile services made available by content providers (e.g., weather information), then there is little point in network operators maintaining

Figure 3: M-Commerce Value Network (Coursaris & Hassanein, 2002)



network service (e.g., GPRS), technology vendors manufacturing wireless products (e.g., handsets), service providers offering wireless products and services (e.g., wireless network access), or developers formulating applications (e.g., wireless chat).

- **Network operators:** Arguably the second most significant party after the customer in the m-commerce value network is the network operator (or network carrier). Network operators are crucial in the success of the m-commerce industry, as they are responsible for a wide range of activities. Such activities include deciding if and when to invest in network infrastructure supporting nonvoice services, educating customers about the availability and uses of these new services, and incurring additional expenses to support compatibility with networks of other operators. Such companies typically utilize a subscription fee business model with customers, as well as a transaction-based fee (e.g., per "hit") business model with content providers.
- **Application developers:** Application developers include software developers and systems integrators that provide a wide range of services, such as hosting and transaction processing. Ultimately, these companies are responsible for delivering a practical solution for customers enabled through available technology. Thus, if they are successful in identifying and addressing customer needs, returns will be high for all involved in

providing nonvoice mobile services. Developers may offer off-the-shelf products (e.g., chat programs), customized products developed specifically to meet one customer's requirement, or hybrid products based on generic products that are further customized with application-specific data. Typically, the business model adopted by these companies is based on software licensing fees, utility transaction costs, and subscription fees.

- **Service providers (SPs):** Similar to the various Internet Service Providers (ISPs) for the wired Web, Mobile Service Providers (MSPs) emerged to provide an easy way for customers to gain access to wireless networks and available solutions. In addition to this function, some literature includes content providers and operators under this category, as they have come to expand their offerings into the area of servicing customers as well. Strictly speaking, however, MSPs sell products and services of others under their name to customers.
- **Technology vendors:** The mobile value network member that transforms what is desired and theoretically designed to what is actually available is the technology vendor. They supply the necessary hardware and some of the software to enable the convergence of telecommunications and IP networks, ranging from transmission towers to mobile handset receivers. Internally, this group is made up of companies concentrating on different aspects of infrastructure; these further classifications can be seen in Figure 3, where the value network members are titled "technology platform vendors" (e.g., Palm and Microsoft), "infrastructure and equipment vendors" (e.g., Alcatel and Ericsson), "application platform vendors" (e.g., IBM and Motorola), and "handset vendors" (e.g., Palm and Compaq). These groups need to coordinate their efforts to prevent market inefficiencies, such as delays in releasing appropriate handsets for the latest networks made available (e.g., the case with WAP-enabled handsets). Such inefficiencies can cause not only financial turmoil for some of the players but also even complete abandonment and failure of new technology initiatives. The typical business model is based on sales or leasing, as well as license and maintenance fees applicable for software.
- **Content providers:** The information a customer accesses when using the wireless Web may be made available through content providers (e.g., Reuters), content aggregators (e.g., digitallook.com), or portal providers (e.g., Yahoo!). For simplicity, these threes types (or subsets) of companies are grouped here as "content providers." The typical business model is based on advertising and subscription fees. Content providers in the

mobile industry currently tend to enter into exclusive agreements with network operators, giving rise to what is known as the "walled garden," where subscribers to specific network carriers gain access to an exclusive set of content providers. This is a symptom being addressed in efforts to provide a truly ubiquitous wireless network that is not only technologically compatible but also offers unrestricted access to content to all mobile users, regardless of carrier selection.

Revisiting the mobile value network while bearing in mind the m-consumer's needs and concerns for business applications would highlight the areas for which each of the value network members is responsible. A summary of these responsibilities is given in Table 3. While this summary is not exhaustive, it highlights the most pressing areas for consumers and the actions necessary to be taken by each of the value network members. Through the aggregated progress of these market players, m-commerce has the potential of realizing its potential growth in the m-consumer segment.

M-COMMERCE CONSUMER BUSINESS APPLICATIONS

In this section, various business applications targeting the mobile consumer will be reviewed, and how they address the interdependence of the three areas already discussed in this chapter (i.e., wireless technology, m-consumer interaction, m-consumer needs/concerns) will be discussed. (This discussion is summarized in Table 4.) The characteristics identified for each business application, in the table, include the following:

- Consumer needs addressed by the business application (identified through this research).
- Interaction modes covered by the business application (based on Figure 2).
- Global market size (in users), unless otherwise noted, if available (sources are referenced in the table).
- Perceived value and willingness to pay for the business application (Daum, 2001; Wong, 2001).
- Concerns associated with the business application (referring to section "Matching m-commerce needs and concerns").

Table 3: Mobile Value Network Member Responsibilities to M-Consumer

m-Commerce Value Network Members	Cost	Privacy	Security	Usability	Reliability	Download Times	Content Availability
Network Operators	Offer network access at reasonable rates	Disclose & enforce a strong privacy policy	Implement latest network security measures	N/A	Maintain high network reliability	Enhance / optimize networks to support high transfer rates	Implement networks supporting rich content; Offer incentives to content providers
MSPs	Offer products & services at reasonable rates	Disclose & enforce a strong privacy policy; Seek TTP approval	Endorse latest network security measures; seek TTP approval	Develop portals with high degree of usability	Maintain high system reliability; Seek TTP approval	Enhance / optimize systems to support high transfer rates	Create portal with large content base; Offer incentives to content providers
Technology Vendors	Offer products at reasonable rates	Offer technology enhancing privacy in products	Implement latest device security measures	Develop devices with high degree of usability	Develop products with high reliability	Develop products supporting high transfer rates	Develop products supporting rich content
Application Developers	Offer applicat-ions at reasonable rates	Offer measures to help support privacy protection in applications	Implement application security measures	Develop applications with high degree of usability	Develop applications with high reliability	Develop applications supporting high transfer rates	Develop applications supporting rich content
Content Providers	Provide content at reasonable rates	Disclose & enforce a strong privacy policy; Seek TTP approval	Secure websites	Develop websites with high degree of usability	Develop websites with high reliability	Optimize web content for fast download	Constantly generate new content of interest

Table 4: Characteristics of M-Commerce Consumer Business Applications (Coursaris & Hassanein, 2002)

Business Application	Needs[1] 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

- Technology requirements for the business application (supported in the remaining discussion).

The applications presented in the table are those of highest interest to consumers, according to research (Daum, 2001; Wong, 2001), 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 4, according to which need they predominantly cater.

Communication Applications

By examining the needs satisfied through communication applications, it becomes apparent why satisfying the need for communication represents the foundation for satisfying all the remaining m-consumer needs. From the "Interaction Mode" column in Table 4, it is evident that only communication applications target all of the different consumer interaction modes. As such, these applications can cater to a wider audience, whose members appear to be more interested in and more willing to pay for this type of application.

Cost appears to be the primary concern and would thus require network carriers to revisit their pricing models, and consequently come up with various options (i.e., subscription, pay-per-use) in an attempt to satisfy different consumer preferences. Finally, with respect to technology, only "data transfer" is affected by the slow adoption of 2.5G, because 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 are 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 provide 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 Web sites suggests an opportunity for content providers to start charging mobile consumers for their

services, if they are not doing so already (i.e., subscription, pay-per-use).

Cost and usability take front stage in terms of m-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 potential 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 m-consumer needs. Gaming appears to currently be the hottest segment, with emphasis on the teenage and young adult communities (Ovum, 2001). 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. For cost, downloads can be purchased individually or through a subscription, giving m-consumers added flexibility. 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 (Harmer, 2001).

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 is not subject to the latest video and audio technologies; rather, it is an important provision for mobile consumers and their need 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.

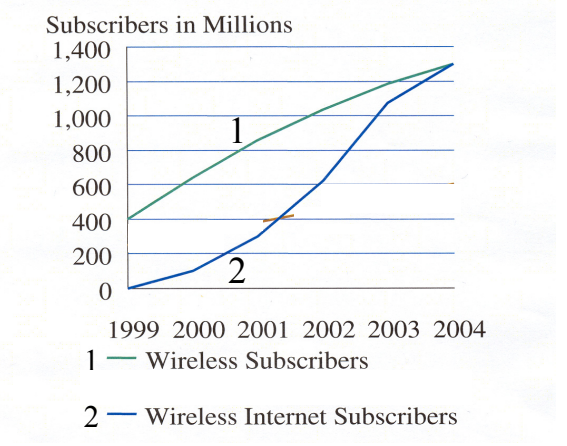
Cost and usability are present concerns once again, but due to the sensitive nature of the information exchanged in a commercial transaction, security and privacy concerns prevail. The limitation in addressing these concerns effectively today lies in the existing infrastructure. The two main points of potential hack attacks were identified earlier in the chapter and were found to be the "Two-Zone problem" or the "WAP Gap" as well as "eavesdropping." The WAP Gap can be addressed effectively in devices accessing GSM networks, as these devices handle the conversion from WTLS to SSL internally on the SIM (Subscriber Identity Module) card and, therefore, minimize the risk of a hack attack and improve overall performance as airtime required for conversion is reduced. Other options are explored through new technologies, including WIM (Wireless Identification Module) cards that are similar in functionality to SIM cards for non-GSM phones, and J2ME-enabled handsets, which allow the handset to send and receive content directly to and from the HTML server, respectively, without the need for an intermediate gateway (Schwartz, 2000). On the other hand, protection against eavesdropping would require more efficient encryption algorithms (e.g., 128-bit) as well as supporting wireless technology enabling these algorithms (e.g., more powerful wireless devices that are not constrained by battery life or memory). Also, frequently, security features are sidestepped in return for time benefits (mobile users omit or deactivate security features to save on transmission time). Therefore, until security enhancements to wireless technology 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 retaining these mobile users for the long run.

GLOBAL M-COMMERCE MARKET OVERVIEW

The growing importance of m-commerce is fueled by the phenomenal growth in the wireless market in general. Shown in Figure 4 is the growth experienced in the wireless device market as well as in the subscriber base of wireless Internet services (Morrison, 2001).

According to these forecasts, the global customer base for wireless Internet access is expected to match the overall wireless subscriber base by 2004 (more than 1.2 billion subscribers, or 20% of the world's population)

Figure 4: Global Subscriber Base for Wires and Wireless Internet Access (Morrison, 2001)



Source: Ovum

(Morrison, 2001). This represents the number of users who have access to the wireless Internet but may not necessarily be using it.

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 5, 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 (Canvas, 2001). As such, m-commerce represents a market with substantial financial returns, along with additional benefits, such as improved branding and customer service through exploitation of the fast-growing wireless channel. According to Table 5, the fastest growing and largest markets for m-commerce are found in Asia, and, in particular, in Japan, followed by Europe.

A frequently asked question within the m-commerce industry is in regard to the killer application: Is there a killer application, and if so, what is it? Although one will be confronted with many answers, each supported with its respective rationale, a more likely scenario is that killer applications for m-commerce will vary by culture and by country. This is evidenced at this early stage of m-commerce by the varying demand for wireless applications around the world. In Europe, the killer application has been Short Message Service (SMS); in Japan, interactive games and pictures; and in North America, e-mail via two-way interactive pagers (e.g., RIM's BlackBerry) plus WAP-based wireless data portals providing news, stocks, and weather information.

Table 5: Regional M-Commerce Revenue (US$ billion) (Canvas, 2001)

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

These "killer applications" will take on many forms as the wireless networks and devices evolve, always improving network connectivity, device form factors, and capabilities. One expectation is that content, services, and applications for wireless devices will become increasingly available.

An overview of the three leading markets for m-commerce is provided next, in an attempt to understand the variations that exist in the adoption of m-commerce services in these different geographic markets.

Europe

With GSM being the single digital mobile telecommunication standard implemented, European countries are positioned well in their race to mobility. GSM has international roaming capability, it is supported in over 159 countries, and it accounts for over 64% of the world's wireless market (Evans, 2001). Consequent of the uniformity in network implementations in this region, market penetration is highly feasible, as interoperability issues are minimized. The last hurdle that network carriers will have to overcome is the estimated cost of US$80 billion necessary to upgrade the existing digital phone networks to accommodate 3G (Dorey, 2002).

To generate much revenue for the continuous upgrade efforts, as well as to alleviate the cost from the high license fees, the availability of wireless applications that are in demand becomes critical. According to the GSM Association, in Europe, SMS has been one such wireless application, for which

demand exceeded 50 billion global text messages sent within the first quarter of 2001. During the same period in the United Kingdom alone, customers generated 3.5 billion text messages. SMS has been popular not only for messaging between wireless users but also as a marketing medium through which m-consumers can respond to television shows (e.g., MTV) that encourage audience participation. Due to the above demand for SMS, it has been coined as the "killer app" for Europe (Evans, 2001).

Extending from the communication applications, Europe also launched initiatives with transactional capabilities for commerce. One example is the m-shopping service provided by the Safeway grocery chain. Through PDAs provided by Safeway, m-consumers can create shopping lists and submit orders. These orders are then sent to the store, where the staff is responsible for collecting and packaging the purchased items for the customer to pick up (Evans, 2001).

In general, Europeans are receptive to m-commerce due to various factors. An industry-related factor involves the pricing strategy adopted by network carriers, who implemented a "caller pays" model for voice communication. Cultural factors include a "café" culture (i.e., a tendency to be active away from home), as well as patience in using many keystrokes in generating text messages and e-mails on their wireless phones (Dorey, 2002). Finally, with an effective transportation system and relatively high gas prices, Europeans end up spending a lot of time on public transportation, with time on their hands. This provides them with strong motivation for using the wireless devices to invoke m-commerce services. Together, the above factors result in a higher acceptance of m-commerce.

Asia-Pacific

One of the biggest success stories for the wireless industry has come from the Asia-Pacific region. NTT DoCoMo's i-mode is Japan's largest network carrier, with more than 30 million customers, capturing 59% of the domestic wireless market (NTT, 2002). Since i-mode's launch three years ago, the respective adoption rate and revenues generated have been the envy of wireless carriers around the world. This growth has been due, in part, to NTT DoCoMo's exclusive offering through i-mode, as competing network carriers operating in WAP could not offer comparable wireless content and services. Using packet data transmissions, fees for wireless services are charged by the amount of data transmitted and received rather than the amount of airtime.

Pioneering many of the wireless services worldwide, i-mode users have access to mobile banking, travel reservations, restaurant and town information, messaging services for news, i-mode-compatible Web sites, e-mail, entertainment sites, and downloadable ring tones. Some of the content is made available by DoCoMo at no cost to the user, while other content is subject to a monthly fee that ranges from 100 to 300 yens per month per offering.

The popularity of wireless services helped maintain a momentum that brought 3G to the Japanese market in the third quarter of 2002. With nearly 150,000 mobile phones being ordered, only 4500 were actually given out in this initial phase of "FOMA," which stands for "Freedom Of Mobile multimedia Access." Of these phones, 1200 were equipped with a video screen to facilitate some of the 3G-supported wireless applications, such as video playback (Evans, 2001).

In general, the Japanese culture has embraced technology, and along with the low-cost alternative of accessing the Internet (aided by a lower PC penetration compared to Western Europe and the United States) and charging based on data volume for wireless services, m-commerce has been very successful in Japan and is experiencing growth in other countries within this region (in particular, China and Hong Kong) (Dorey, 2002). Finally, with a similar transportation situation to that of Europeans, Japanese consumers end up spending a lot of time on public transportation with time on their hands. This provides them with a strong motivation to use the wireless devices to invoke m-commerce services.

North America

The United States has been leading the way in adoption of wireless technologies in this region, followed by Canada, who is catching up on various levels (e.g., m-commerce growth, penetration of wireless devices). Overall, however, North America has been known to lag behind Japan and Europe in its m-commerce efforts. Several factors contribute to the slow adoption of m-commerce in North America. One of these factors has been interoperability, as there are six U.S. and four Canadian national network carriers that operate on different network standards (Dorey, 2002). This lack of common network standards will pose an even greater challenge to overcome (in particular, financially) in their efforts to evolve to a 3G environment. Furthermore, high PC penetration rates and a low-cost alternative for voice communications offered through wired telecommunications service do not create a desirable m-commerce-value proposition for consumers.

Culture appears to be acting as a barrier for m-commerce as well. North Americans, in general, exhibit a "stay-at-home" social outlook. Also, there has been a demonstrated lack of patience and an expressed dissatisfaction with the usability of currently available wireless devices (e.g., challenging to generate e-mails on a wireless phone). Finally, little knowledge of wireless technology and applications by the average North American consumer poses yet another challenge for m-commerce adoption (Dorey, 2002). Another factor contributing to the slow adoption of m-commerce in North America could be the affinity of North Americans to driving their own cars. The public transportation infrastructure is inferior to both Europe and Japan. The cost of owning and operating a vehicle is lower compared to that in Europe and Japan. All of these factors combine to instill a driving culture in North America. For example, because most people drive to and from work every day, they are not in a position to use mobile devices for m-commerce services during their commute.

Consequent of the above issues, the wireless consumer market has been small. However, the business market has been more responsive. In particular, one of the major trends in the United States has been the use of Research In Motion's (RIM) wireless devices for receiving and sending corporate e-mail. Through an always-on service for wireless e-mail using the DataTAC and Mobitex wireless networks, many companies adopted this technology to further enable their organizations. In addition, wireless Web access via WAP-enabled cell phones is a growing application in the United States (Dorey, 2002).

DISCUSSION AND FUTURE TRENDS

The m-commerce industry is fast growing, with estimates of reaching a user base of 1.3 billion people around the world by 2004 (Morrison, 2001), contributing to an overall market in excess of US$22 billion (Canvas, 2001). 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 ranging from technology limitations or limited business applications. Concerns center on the issues of cost, privacy, reliability, download speed, usability, security, and content availability. For m-commerce to reach its potential, these concerns will have to be effectively addressed, and collaboration among all value network members will be essential. 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.

The traditional categories for wireless devices include wireless phones, wireless PDAs, and wireless laptops. The latest innovation in wireless devices involved the introduction of smart phones, which represent wireless devices that enabled users with a new set of capabilities, derived from more than one of the traditional wireless devices. 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 (Keyte, 2001).

With respect to wireless communication protocols (e.g., WAP, i-mode), it is unlikely that any one will prevail over the others on a global basis. The more likely scenario will be that wireless devices will evolve to support all protocols seamlessly. This is one of the goals set to be achieved with the implementation of the 3G wireless networks (hence, the name UMTS). Wireless networks will continue to be implemented that offer higher bandwidths and, consequently, can support rich content, such as streaming video, at faster download times than those available today. Japan is leading the rest of the world, having implemented their 3G network in the fourth quarter of 2001 and having already announced that 4G is expected to arrive in 2006 (NTT, 2002). Although 4G will provide higher bandwidth than 3G, it is the latter that will help address the main problem of ubiquity. Ubiquity is a critical success factor for m-commerce, and with the whole world eventually migrating to 3G, there will be no more barriers to prevent anytime, anywhere m-commerce.

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 environments. It may be the case that before long, language interpreters or translators will convert a single Web site to any standard, taking into consideration the form factor involved. For now, these applications are still 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 managing the associated complexities. Consequently, additional resources are required that are estimated at 30% above the cost of implementing an HTML Web site (Little, 2001).

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 the needs and wants of the m-consumer, as outlined in this chapter, can facilitate 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 comes from the Far East, where Japan successfully captured 30 million users in less than 3 years on its i-mode platform. 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 (Levy, 2001). 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.

Asian countries, in particular, Japan, are expected to continue to dominate the m-commerce market in the near future, although the rest of the world, in particular, Western Europe, is closing the gap. It will be interesting to see how underdeveloped countries will respond to the m-commerce opportunity, which can act as a "leapfrog" technology. M-commerce can reduce the digital divide between developed and underdeveloped countries by allowing underdeveloped countries to implement wireless networks that will serve as their main communications infrastructure.

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. Developers of 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 mobile devices and m-commerce Web sites, because it is highly related to the rate of adoption of m-commerce activities by m-consumers.

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ENDNOTES

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 Service; EDGE: Enhanced Data for GSM Evolution.

3 W-CDMA: Wideband CDMA; UMTS: Universal Mobile Telecommunication System.

4 D-AMPS: Digital AMPS; CDPD: Cellular Digital Packet Data; PDC: Personal Digital Cellular.

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: 2.5G is available but is not yet widely used.)

[9] Source: allNetDevices, http://www.canvasdreams.com/viewarticle.cfmarticleid=941; except A = ARC Group, 1999, http://www.epsltd.com/IndustryInfo/Statistics/mobilestats.htm, and B = Datamonitor, 2000, http://cyberatlas.internet.com/markets/wireless/article/0,,10094_455141,00.html.