2 Mobile Computing Applications – Supporting m-Business and m-Government

Mobile Sales on the Move

Mobile sales solutions are one of the fastest growing CRM (customer relationship management) sectors at present. Large and small companies have been spending heavily to keep sales agents connected through mobile devices and wireless networks. A Yankee Group report projects that investment in mobile sales solutions will jump from $132 million in 2002 to $825 million by 2006. Gartner research has also projected that by the end of 2003, more than 20 percent of all businesses would be investing in some sort of mobile sales force automation solution.

What do they do? Mobile sales solutions provide field salespeople real-time access to data – one of the central appeals of CRM providers. Real-time support in the field through mobile devices can deliver up-to-the-minute quotes and ensure that orders can be filled. Sales reps using a mobile solution can take orders, give real-time quotes, and ensure that items are in stock and can be delivered on time.

While many mobile sales solutions are being implemented by large corporations, several small-to-medium businesses (SMBs) are also getting into the act. An example is GEMS, a Dallas-based professional services and technology solutions support company with around 100 consultants that support customers in 40 cities across the US. Before July 2003, GEMS business primarily operated on spreadsheets and accounting programs such as QuickBooks. This was not suitable for growth. More seriously, the company was missing revenues because it had no way of reconciling revenue versus cost. The consultants faxed in their billing sheets and other sales documents, creating a huge challenge to update all data on a timely basis.

The company chose to add a mobile module to the company's mySAP CRM system. Now the consultants have instant access to an integrated system. They can input data, easily draw the information they need, and interact with other associates through mobile devices. With the new system, the consultants can cover more accounts, they have instant access to critical data, and the company has facilitated better communication between consultants who are spread out across the country. As a result of the mobile system, productivity has increased 10 to 15 percent and GEMS was able to double its revenue target for 2004.

The key enabling technologies for mobile sales force automation are not only the cellular networks but the Wi-Fi hotspots that are proliferating everywhere. In addition, the new "convergent" devices that operate on hybrid networks are more capable of handling the complex processing of mobile SFA (sales force automation) applications Thus disconnected salespeople can now easily access data repositories from Wi-Fi hotspots plus cellular

networks nationwide by using powerful mobile devices.

Mobile sales solutions are very popular with pharmaceuticals and high-tech manufacturing companies. The pharmaceutical mobile sales solutions allow sales reps to access physician profiles, call reporting, industry information, drug interaction information, messaging, and sample compliance. The high-tech industry is adopting mobile sales solutions quickly because most already have some sort of SFA solution in place. In this case, they simply add a wireless component to the existing SFA system to expand the use of SFA but also make better utilization of their sales force.

Source: M. Schneider, "Mobile Sales is on the Move," *Destination CRM*, April 01, 2004.

2.1 Introduction

Mobile computing applications are the key enablers of m-business. Beyond business, these applications are also supporting our daily life by providing wireless access to health services, government services, entertainment, and other social activities. These applications enable the C2B, B2B, B2E, C2G, B2G, G2G, and G2E operations between customers, business units, government agencies, and employees (see Figure 2-1). The following core mobile computing applications are being used, with minor and necessary modifications, for m-business and m-government initiatives:

- Wireless messaging services
- Wireless websites and mobile portals
- Mobile e-commerce and its variants
- Mobile customer relationship management systems (M-CRM)
- Mobile supply chain management systems (M-SCM)
- Specialized applications involving mobile agents and wireless sensor networks

Table 2-1 shows how these core applications support the m-business, m-government and mobile life initiatives. This chapter provides a detailed discussion of these applications.

Table 2-1: Mobile Computing Applications and their Support to m-Business, m-Government, and Mobile Life

Mobile Computing Applications	m-Business	m-Government	Mobile Life
Wireless messaging services (email, SMS, MMS)	SMS for B2E	G2C, G2G, G2B, G2E	Social messages
Wireless Web and m-Portals	m-Marketing, enterprise portals with wireless access	Government websites and portals with wireless access	Websites accessible through wireless and m-portals such as Mobile Yahoo!
Mobile Commerce	m-Commerce	C2G for tax payments, etc.	Buying tickets for theater
M-CRM	M-CRM	Not Clear	Not Clear
M-SCM	Supplies of materials in B2B	Supplies of goods in G2G and G2B	Not Clear
Specialized m-Applications	LBS (location-based services), Mobile Agents for m-commerce, and wireless sensor networks (WSNs)	m-Voting Defense applications of Mobile Agents and WSNs	Location-based services to locate nearest restaurants, movie theaters, and repair shops

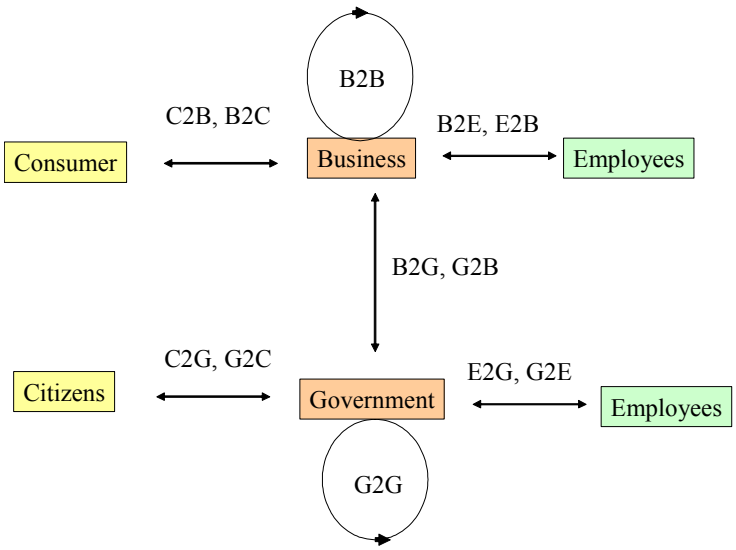

Figure 2-1: Interactions between Consumers, Business Units, Government Agencies, Citizens, and Employees

Chapter Highlights

- Mobile computing applications support m-business, m-government, and mobile life initiatives. Specifically, these applications enable the C2B, B2B, B2E, C2G, B2G, G2G, and G2E operations between customers, business units, government agencies, and employees.
- Most mobile computing applications are not fundamentally new applications. Instead, mobile device access over wireless networks is another aspect (dimension) of most existing array of applications.
- Most mobile applications include several capabilities called MPTV (Mobile, Positional, Television, and Voice). Many of these capabilities, such as positional services, are included as value-added features in mobile computing applications.
- Although the applications differ from each other, several common attributes can be found. A generic architectural framework can represent a wide range of EB applications. The business logic can change but the overall architectural framework is the same.
- Wireless messaging is an important development that is most widely used at present. Commonly known as "always-on email," these services include short message services (SMS), multimedia message services (MMS), and Blackberry from Research in Motion (RIM). These applications are used widely in m-business, m-government, and mobile life situations.
- m-Commerce entails using mobile devices to search the Internet, access data and information, and conduct purchasing or business transactions. One of the main value propositions of m-commerce is its ability to personalize applications for individual users. m-commerce has not been as widely successful as initially thought.
- Many mobile computing applications such as mobile portals, mobile customer relationship management systems (M-CRM), and mobile supply chain management systems (M-SCM) are mobile enablements of enterprise business applications. These *mobile* enterprise business applications (MEBAs) add mobility capabilities to the core enterprise applications (ERPs, SCMs, CRMs, etc.) for availability to employees, partners, and customers who could be roaming around the globe.
- Location-based services (LBSs) are expected to be a major area of growth. These

applications support E911 services for cellular network users and can support location-based maps, child finders, and many other applications.

- Wireless sensor networks (WSNs) consist of extremely small sensors, or nano-computers, that can be "sprayed" in a particular area to gather information. Many military and business applications of WSNs are currently being developed.
- Mobile agent applications represent a different class of applications in which the application programs themselves are mobile. In this type of application, mostly implemented through Java code, the application code may itself migrate from the back-end system to your handset and then move to another site.

The Agenda
- Overview and Mobile Messaging Services
- M-Commerce, M-Portals, M-CRM, M-SCM
- Specialized Mobile Applications and Examples

2.2 Key Characteristics of Mobile Computing Applications[1]

2.2.1 Highlights of Mobile Computing Applications

Most mobile computing applications, especially in the domain of mobile e-busisness applications (MEBAs), are not fundamentally new. Instead, mobile device access over wireless networks is another capability that is being added to the current array of applications. Most suppliers of enterprise software are adding another mobility module to their current suite of enterprise applications. For example, SAP has added mobility modules to its suite of ERP (enterprise resource planning) applications. Siebel, Oracle, and PeopleSoft have followed similar approaches. In fact, most companies that are using mobile computing applications at present have extended their current corporate applications to include mobility. A good example is mobile CRM – most early adopters of M-CRM are the companies that already have a CRM in place and are now adding mobility features to support a mobile sales force. Of course, there are exceptions to this. In particular, development of wireless sensors, mobile agent applications, and some location-sensitive applications are fundamentally new applications that are unique to wireless and mobile computing.

While many mobile computing applications have been developed, and more will be developed in the future, the search for "killer" applications – the applications that are phenomenally successful – continues. In reality, the killer mobile applications may vary by industry type, country, culture, and individual user. For example, mobile messaging services such as SMS are very popular in m-government, and M-SCM systems are more popular in manufacturing organizations. It is not enough to build a good application with nice features; other factors should be considered for market adoption. The market adoption of an application can be hindered by social barriers such as privacy concerns, business barriers such as revenue expectations, and technology barriers such as product maturity, usability, bandwidth, and cost.

[1] m-Portal, m-CRM, m-SCM are also written as M-Porta,m-CRM, and M-SCM, respectively.

The killer applications create business value or meet unmet needs. So how are the mobile computing applications creating business value? Here are some possible ways, suggested by [Kalakotta 2004]:

- **Mobile asset management**. Large companies have their assets (equipments, finished goods, raw materials, support materials, computing devices) at different locations. Mobile asset management systems (MAMs) allow the plant maintenance technicians, warehouse supervisors, and other employees to scan and capture the information about assets on-site through mobile devices. This information is then submitted electronically to the corporate systems, instead of through a paper-based system where the information is gathered manually and then entered manually into the corporate system. An example is the use of MAM at Frankfurt Airport (see the case study in Section 2.10.1).
- **Mobile field service**. The field service technicians, when on call, use mobile devices to record the activity on-site, what was done, customer comments, etc. This log of activity is sent to corporate systems electronically. As different technicians work on the same problem, each technician can download relevant activities so far, take appropriate actions, and then log additional activities as they are performed. One of the largest users of this feature is UPS, whose parcel delivery drivers record the delivery information, customer signatures, etc. on-site (see the UPS case study at the end of Chapter 1).
- **Mobile sales support**. Real-time support of sales force in the field through mobile devices is highly valuable because sales reps can take orders, give real-time quotes, and ensure that items are in stock and can be delivered on time before closing a deal. Due to these benefits, mobile sales support is one of the fastest growing mobile computing application. See, for example, the chapter-opening case study "Mobile Sales on the Move."
- **Mobile procurement.** The ability to acquire products quickly provides many benefits to organizations. Employees in the field can use a mobile device to search catalogs, compare prices and availability, and place orders without having to call the central office or waiting to return to the office. This application is not limited to businesses only. The physicians in Children's Hospital in Wisconsin can order new drugs quickly when they visit a patient by using a wireless-enabled laptop that they wheel around on a mobile cart during their patient visit.

The mobile computing applications that provide the aforementioned business value can be discussed in terms of the traditional C2B, B2B, and B2E applications. We will stretch this a bit by using B/G instead of just B to signify the role of government in mobile applications [Evans 2001].

- **Mobile C2B/G.** Mobile enablement of customers can take many forms: specialized cell phones or pagers to increase customer loyalty; access to hotel and airline reservations and information; telematics services for emergency location and assistance; wireless access to order status information; product and service information via wireless enablement of a corporate website; alerts and notifications on items of interest; location-based services for marketing; unified messaging for customer support.
- **Mobile B/G2E**. Wireless enablement for employees basically gives employees the access to the information and transactions they need in order to perform their work-related activities. Wireless enablement can be an extension of existing enterprise applications or it can take be entirely new applications built specifically for use in a wireless or mobile scenario. These applications, if done right, can have a profound productivity improvement for employees, the sales force, the field force, and for executives within an enterprise.
- **Mobile B/G2B.** The major application in this category is the supply chain that can benefit from wireless enablement in several processes. These include purchasing, manufacturing,

distribution, and customer service and sales. Different types of mobile technologies have been used in supply chains, ranging from bar code scanners to wireless sensors and RFID tags for improved data capture and asset management. In particular, handheld devices with Symbian and Windows CE operating systems connected with Wi-Fi LANs offer extensive opportunities for monitoring the supply chains at almost all points. Newer systems are using wireless sensor networks to detect any damages to the goods during transit and to alert the receivers and the senders for appropriate action.

2.2.2 Mobility of Users, Target Sources, and Networks

Mobile computing applications have to consider the mobility of users, target information sources, and the networks that interconnect them. Basically the following scenarios are possible:

- Users (mobile or fixed)
- Networks (mobile or fixed)
- Target information source (fixed, mobile)

Table 2-2 shows what type of networks are needed for mobile or fixed users/information sources. The applications for fixed users and fixed information sources are not mobile applications, while most of the mobile applications being developed at present are for mobile users who need access to fixed information sources. Although mobile information sources are relatively rare at present, this situation will be more common as more data and applications move to mobile devices.

We can also add another dimension to this discussion. We have assumed that the programs are static even when the devices are mobile (i.e., the same programs are on your laptop when you travel around). We can now consider the mobility of code (known as ***mobile agents***) as another dimension. In this case, you could have the situation where your code is mobile but the device is not, and vice versa. We will discuss mobile agents in a later section (Section 2.9).

Table 2-2: User Device versus Information Source Mobility

	Fixed (non-mobile) User (e.g. using a Desktop)	**Mobile User (e.g., using a Mobile Device such as Cellular Phone)**
Fixed Information Sources (e.g., a website, database or application on a mainframe)	Application example: Desktop access to a website or to a back-end application. Networks needed: Traditional wired networks, can possibly use a fixed wireless network	Application example: cellular access to websites or back-end applications. Networks needed: Wireless, can possibly use a wired network with mobile devices over wired networks (e.g., laptop connecting over dial-up). can be hotspots
Mobile Information Sources (e.g., laptop application, database on a mobile device)	Application example: Desktop access to laptop and PDA applications and databases Networks needed: wireless or fixed, with mobile devices over fixed networks can be hotspots	Application example: Cellular access to info located on a laptop Networks needed: wireless networks are the only solution

2.2.3 Adding Other Capabilities (Positional, TV, and Voice) to Mobility

Mobile computing applications have several variants that could be called MPTV (mobile, positional, TV, and voice) services. In reality, many "M" applications are adding V (voice), P (positional, also known as location) and T (television) capabilities as value-added services. We will use the term mobile computing application to imply one or more capabilities of MPTV, unless otherwise specified.

Mobile computing application = mobile + positional + television + voice

Mobility capabilities describe the phenomenon of using wireless mobile devices such as digital phones and PDAs to search the Internet, access data and information, and conduct purchasing or business transactions. m-Commerce is fueled by the extreme popularity of mobile devices such as laptop computers, cellular phones, PDAs (personal digital assistants), and Palm Pilots. However, the vast majority of devices and usage continue to depend on laptops and PCs, which may remain the de facto standard of devices used to access enterprise data and applications. Although the mobile PDA and telephone device markets are growing rapidly, the growth in the North American market is slower than in the European and Japanese markets.

Voice capabilities are gaining in importance to support users who want to use telephones and other voice-driven devices for conducting e-commerce. For example, while driving or walking, it is easier to use a telephone than a computer. Technologies and standards such as Voice over IP (VoIP) and Voice Markup Language (VXML) will play a key role in v-commerce.

Positional capabilities are providing support to the customers based on their geographic position (e.g., giving you information about deals in the Boston area when you are in Boston). Many systems use a GPS (Geographical Positional System) to locate the position of the customers. But other approaches such as AoA (angle of arrival) are also becoming popular. Most positional capabilities are becoming available as value-added location-based services (LBSs). See Section 2.8.1 for a discussion of LBS. .

Television capabilities exploit another area of work that involves mobility. The idea is that you can use your TV to do Web surfing and online purchasing. For example, if you see an advertisement of a product on TV, you can then activate a purchase through your remote control. The TV set boxes will be programmed to support T-Commerce.

2.2.4 High-Level Architecture of Mobile Computing Applications

Before proceeding, let us take a quick look at a generic architectural view of EB applications shown in Figure 2-2. This architectural framework shows mobile computing applications as a multi-tiered client/server (C/S) model in which two integration layers surround the business logic. The front-end integration layer takes into account the wide range of mobile and fixed devices (laptops, Web browsers, PDAs, cellular phones) and applications (desktop or mainframe-based) that you need to communicate with. The back-end integration is used to connect to various local as well as remote (external trading partner) applications and databases). Notice that both integration layers are triangular; i.e., the integration glue is thin in some cases but quite thick in others. For example, integration with Web-based applications requires less effort than a mainframe-based application. The integration effort also depends on whether you are interacting with local (i.e., within the same enterprise) or external

applications. This architecture can be used to study the interplays between the infrastructure components and to study integration/migration issues, and to address operational issues such as performance, fault tolerance, security, and manageability.

We will use this architecture throughout this chapter as a framework to illustrate how various mobile computing applications can be viewed as specialization of this view.

The reader should be reminded that the focus of this chapter is on applications and models and not on deep technical/architectural issues. The technical and architectural issues are mentioned only as sneak previews of what is covered in the balance of this book. In particular, see Chapter 11 for architectures of wireless systems.

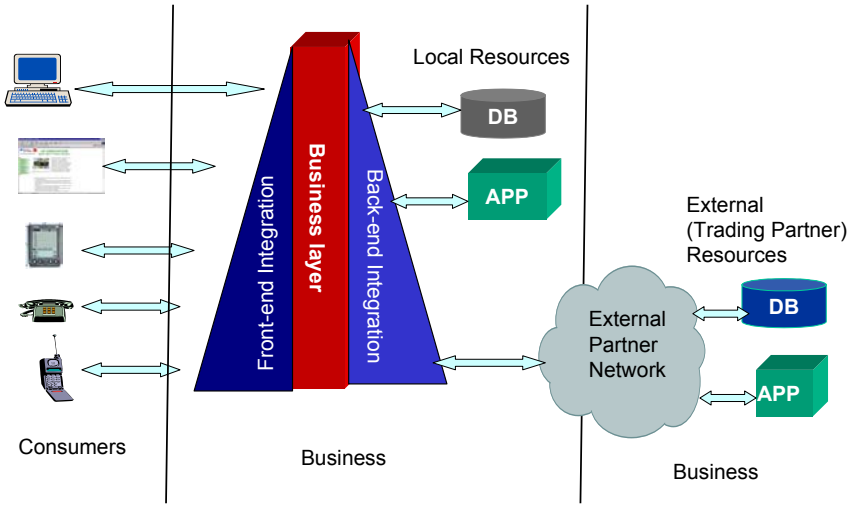

Figure 2-2: High-Level Architecture of Mobile Computing Applications

2.3 Messaging for Mobile Users

2.3.1 Overview and Examples

Mobile users spend a significant amount of time away from their desks and find it important to stay connected to the information that drives their day. One of the most interesting and important developments is messaging for such users. Also known as "always-on email," these services are touted as the long-awaited killer applications for cellular networks. Examples of these services are the well-established short message services (SMS) and the emerging multimedia message services (MMS). Blackberry from Research in Motion (RIM) is a very good example of always-on email services.

To illustrate the use of wireless messaging, let us take the following example of a day in the life of Bob – a marketing VP for a Fortune 500 company:

- Bob is on his way to attend an important meeting at a customer site. He gets an SMS message on his cellular phone that says that the meeting will be an hour late. Bob takes advantage of this hour to get a nice breakfast, read some reports he had stored on his laptop, and plan his day.

- The meeting starts as scheduled. During this meeting, it is decided that the next meeting will be at Bob's headquarters. He wants to schedule this meeting and wants to make sure that there are no conflicts. His secretary keeps his calendar on the mainframe (Lotus Notes). He uses his Blackberry to update and synchronize his calendar.
- Bob's mother is arriving from out of town the same day. She happens to catch an earlier flight. She calls, but Bob is still in the meeting. His notebook PC is wirelessly enabled and his cell phone is on meeting mode, whereby his voice messages are translated to text. Because of this feature, an instant message is created on Bob's PC indicating that his mother is at the airport waiting for him.
- He decides that he cannot go to the airport (it is too far and he is deeply engrossed in the meeting). So he directs his mother's call to his girlfriend, Joan, from his PC and adds a note to Joan asking if she could pickup his mom. Joan gets the call on her cell phone but realizes that she has not seen Bob's mother.
- She calls Bob back. An instant message appears on Bob's PC again. He recalls that he has gif images of his mom's pictures on his PC. So he transmits a good picture of his mom to Joan because he knows that Joan has just bought a cellular phone with MMS (Multi-Media services).
- Joan gets the picture and goes to the airport. She realizes the value of MMS because the sales lady has told her that with MMS one person can tell another that they are in a certain place by sending them a photo of that place. The photo could also be taken with the digital camera on their MMS terminal.

Many technologies and architectures enable these scenarios. For example, the wireless network infrastructure locates and delivers the messages to the mobile users. In addition, middleware services are employed to hide the intricacies of the wireless networks from the messaging applications. Finally, different delivery models are used. For example, instead of the "pull" model where the email clients periodically ask for information from the email servers, a "push" model is commonly used where the needed information is sent to the email subscribers by the email servers. This is useful in wireless systems because the email clients do not have to be connected to keep querying about new emails. We will discuss many of these technologies and architectures in the balance of this book.

2.3.2 Short Message Service (SMS) – Wireless Text Messaging

The Short Message Service (SMS) allows users to send and receive text messages to and from their mobile telephones. The text can be comprised of words or numbers or an alphanumeric combination. SMS was created when it was incorporated into the Global System for Mobiles (GSM) digital mobile phone standard. A single short message can be up to 160 characters of text in length and contains no images or graphics. Although SMS is supported by cellular phones based on different cellular networks, most SMS services are supported by GSM providers.

SMS is particularly good for "pushing" information to mobile phone users. In particular, SMS is used to push alerts, such as "new email from boss," "meeting cancelled," "appointment changed at . . ." etc. SMS can also be programmed to generate alerts from any data changes in corporate databases such as "supply chain is too slow," "inventory levels have dropped below re-order points," and "100 online purchasing items have been received." SMS can also be used to pull data from a database, such as customer street address and fax number. For many of these types of applications, SMS supports a quick response. The main advantage of SMS is that it is simple and quick. The main disadvantage is that it is not meant to support conversational and interactive applications – it is an email service.

SMS has been a huge success in European GSM markets. It has also gained considerable ground in the United States. Instead of corporate efforts, the SMS market has been largely created via word of mouth. The user adoption has been phenomenal, especially in Europe, and has resulted in volumes of 2.5 to 3 billion SMS messages per month. According to the EMC for GSM Association, 2.4 billion messages were sent in May 2002.

SMS is a huge success in several m-government initiatives around the globe because many citizens own cellular phones that support SMS. Thus SMS has become a vehicle to inform the public in many countries. Here are a few examples:[2]

- The state of California has established a Web page where citizens can register to receive wireless PDA and cell phone notification services via SMS for energy alerts, lottery results, traffic updates and articles from the Governor's pressroom.
- A Web and mobile phone service called ChildLocate.co.uk has been launched to help parents keep an eye on kids from a distance. The subscription-based service allows parents to monitor the whereabouts of their children without needing to constantly bother them with phone calls. Parents can access information via the childlocate website and the system uses SMS signals to determine the child's location.
- An SMS text-message service, warning of adverse weather was launched in central China's Henan Province. The system sends forecasts of hazardous weather to the public as part of the bid to minimize any damage.
- The Quezon City government in the Philippines plans to use SMS text messaging to improve garbage collection and establish closer coordination between residents and trash collectors. SMS messages are sent to the citizens informing them about when and where the next trash collection will take place.
- PlanetReunited.com has developed an SMS service by which backpackers can send a message to their parents, family and friends about their whereabouts, even if they cannot get to an Internet café. Registered users can send one single SMS which is posted to a weblog (BLOG) via SMS. Their friends and family can be alerted via text or email when the BLOG is updated.

The primary benefit of SMS to the users is that they can use the same cellular phone for talking as well as short emails. In most cases, people use SMS just to scan the email header ("from" and "subject") and send short replies like "I will get in touch within an hour." Main SMS benefits include delivery of notifications and alerts, guaranteed message delivery, and ability to screen messages and return calls in a selective way. More sophisticated functionalities such as generation of messages are also available.

Figure 2-3 shows the overall architecture of SMS. The heart of SMS is a Short Message Service Center (SMSC) that directs all short messages to and from the mobile phone. The architecture is based on a store-and-forward model. The SMSC receives a message and directs it to the appropriate mobile device. Before sending the message, the SMSC finds the roaming customer by consulting "home location register (HLR)." The HLR part of a cellular network (in reality, HLR is part of a GSM cellular network), keeps track of a customer location. After receiving the request, HLR responds to the SMSC with the subscriber's status: inactive (phone turned off) or active (phone turned on). The SMSC transfers the message to the mobile device if active and receives a verification that the message was received by the end user. If the user is "inactive," then the SMSC holds onto the message and attempts to

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[2] For these and additional examples, see "M-Government: The Convergence of Wireless Technologies and e-Government," www.ec3.org/Downloads/2001/m-Government; and "mGovernment: Mobile/Wireless Applications in Government," http://www.e-devexchange.org/eGov/topic4.htm.

deliver it when the subscriber turns on his/her device. There is some handshaking between the HLR and the SMSC when a user turns on his mobile device – the HLR detects this activity and sends a SMS notification to the SMSC. The SMSC software resides in the operator's network and manages the billing services. Many operators offer Web-based interfaces to their SMSC so that the users can send short messages to any mobile phone from the Web. Some websites offer free SMS.

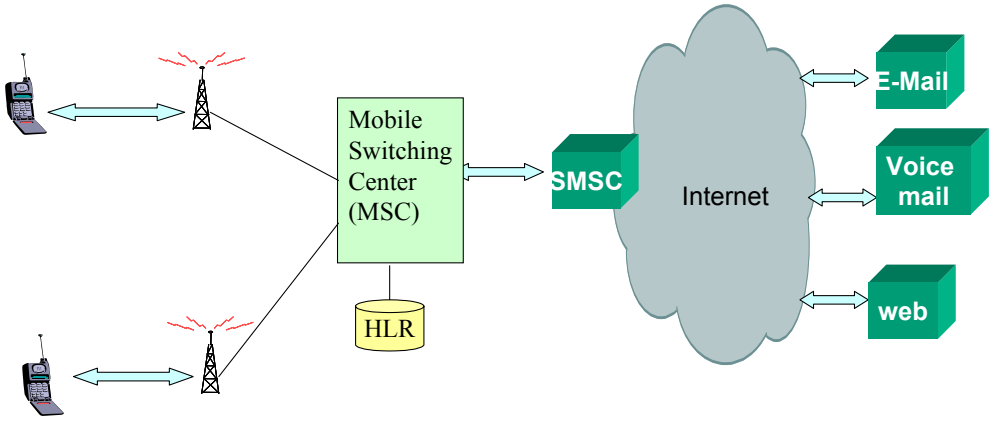


Figure 2-3: SMS Architecture

Users of SMS need the following:

- A mobile phone that supports SMS
- A subscription to a mobile telephone network that supports SMS (usually GSM)
- Knowledge of how to send or read a short message using the specific model of mobile phone
- A destination to send/receive messages. This may be another mobile phone, fax machine, PC or Internet address

An interesting characteristic of SMS is that a mobile handset can send or receive a short message at any time even when the user is talking. This simultaneous voice, data and fax activity is possible because short messages use the signaling frequencies that do not interfere with the radio channel used by voice and fax. SMS uses the signaling path to deliver short-burst data that carries its 160-byte messages. Thus, the users of SMS rarely get a busy or engaged signal. Due to the benefits of SMS, new applications are being developed. Examples include profile-editing, wireless points of sale (POSs), automatic meter reading, remote sensing, and location-based services. Additionally, integration with the Internet is leading to new applications such as instant messaging, gaming, and chatting.

SMS has several benefits. It is very easy to install and use. Due to the guaranteed message delivery, polling is not needed and wireless bandwidth is not wasted. When the SMS provider sees that a user is connected and an SMS message is waiting in the SMSC for the user, the message is delivered. The main drawback of SMS is security because plain text can initiate an SMS message. Because anyone can send such a message, there is a possibility of false alerts. Overall, SMS is a useful and realistic notification service for applications such as email and voice mail.

2.3.3 Blackberry

BlackBerry®, from Research in Motion (RIM), is a popular wireless device that provides quick access to email, phone, SMS, organizer and Web applications. Based on a proprietary and patented system, BlackBerry is an integrated package that includes hardware, software and service, providing an end-to-end solution. It combines wireless handhelds with optional data and phone services and software that integrates with Microsoft® Exchange and Lotus® Domino™. Blackberry also provides end-to-end security with extensive encryption support. Recent versions of Blackberry handsets include an integrated speaker and microphone. Users of Blackberry can:

- Send and receive emails from anywhere
- Place a phone call while reading their email messages in a meeting
- Coordinate a meeting from the lobby of a hotel
- View information from a corporate database while traveling in a train

BlackBerry was designed to meet one major requirement – how to stay connected to one's desktop email and organizer information such as contacts, calendar, tasks and memos while in transit. A common solution has been to carry laptops to answer emails – a very cumbersome option. Typically, mobile professionals use a laptop when traveling and dial in to the corporate email server from a hotel room to read their email. Some use special software to send email notification to a pager or cell phone so they know what is in their inbox before bothering to dial in. Some people have used PDAs to dial in for email. But this is a risky option because of the lack of security software available for the PDAs.

Technically, BlackBerry eliminates the need of dial-up by using a "push" model instead of the traditional "pull" model. In the pull model, the user connects to the corporate email server to check for new messages. In a push model, the email server automatically connects to the user and pushes the new email to the handheld. This provides always-on email service. BlackBerry does not use a separate email address for the wireless handheld.

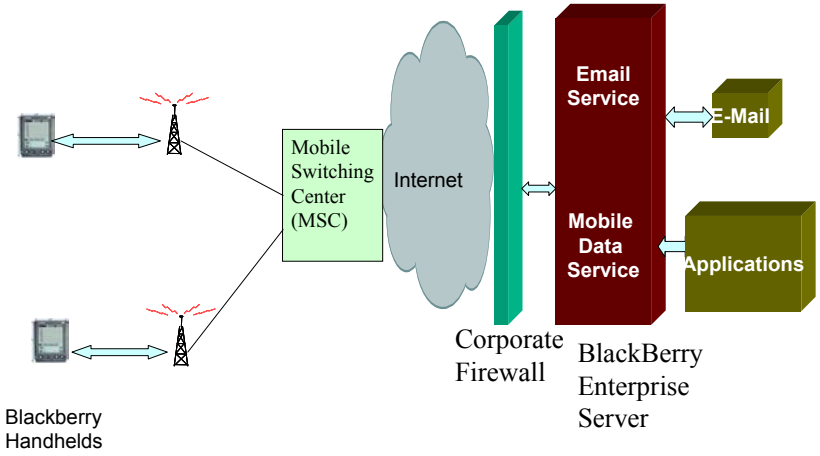


Figure 2-4: Blackberry Architecture

Figure 2-4 shows an overview of the Blackberry system architecture. The key pieces of this architecture are a) email server, b) the BlackBerry Desktop Software's Redirector component, c) the RIM Wireless Handheld and d) the wireless data network. The general operation of the system is as follows:

- Email arrives at the email server for the BlackBerry user.

- The BlackBerry Desktop Redirector is then notified by the mail server. The Desktop Redirector retrieves a copy of the message, compresses and encrypts it and sends it via the Internet to the wireless network.
- The wireless network delivers the message to the handheld.
- At the handheld, the message is decrypted and decompressed and the user is notified of its arrival.

For this email redirection system to operate, users must leave their desktop computers running (a password-protected screen saver is recommended for security). The path from the handheld to the desktop follows the same steps, only in reverse.

2.3.4 Multimedia Messaging Service (MMS) for Wireless

While SMS, or text messaging, has been a huge success in Europe, MMS, mainly picture messaging, has been phenomenally successful in Japan. Simply stated, the Multimedia Messaging Service (MMS), as its name implies, is the ability to send and receive messages comprising a combination of mixed media including text, sounds, images and video to MMS-capable handsets. Conceptually, MMS is a presentation layer for email that integrates multiple presentations from SMS, email, unified messaging and other services on a handset.

MMS has been designed to provide a similar user experience to that of existing services such as SMS, but has been extended to include multimedia elements. It is a non-real-time service and uses a store-forward model similar to SMS. The main difference is that MMS is based on open standards such as WAP (Wireless Application Protocol) while SMS has some proprietary interfaces and architectures. MMS is an open wireless standard specified by the WAP forum for 3GPP (3rd Generation Partnership Project). 3GPP is the new worldwide standard for the creation, delivery and playback of multimedia over high-speed 3G wireless networks. Tailored to the requirements of mobile devices, 3GPP uses MPEG-4, the new standard for delivery of video and audio over the Internet. Although MMS is a 3G standard, network operators across Europe are deploying MMS over 2.5G networks using WAP as a means of transport. We will look at WAP and 3G-2.5G wireless networks later. The MMS phones allow users to exchange messages including still pictures, animations and sounds.

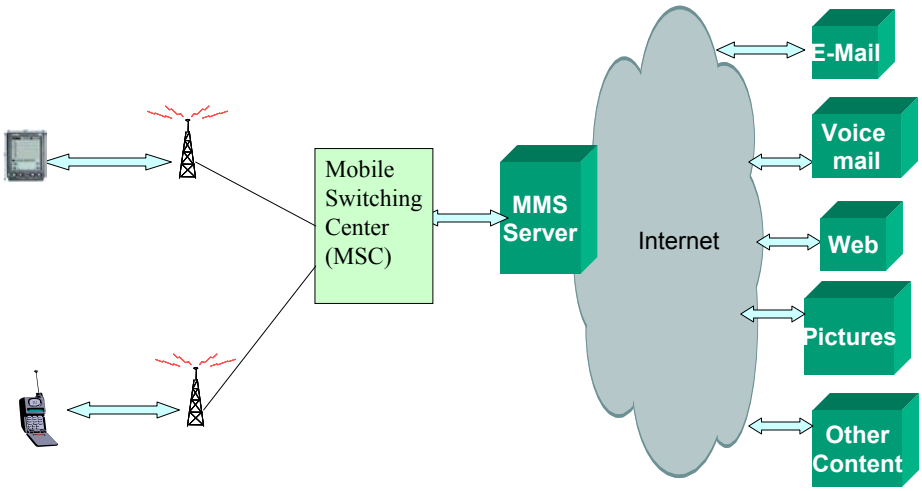


Figure 2-5: MMS Architecture

As shown in Figure 2-5, MMS is a store-and-forward protocol. Messages are stored on an MMS server, which sends the recipient a notification message using WAP Push (similar to an

SMS message). The notification message triggers the receiving terminal to retrieve the message automatically (or depending on filters defined by the user) using the WAP GET command. This allows the receipt of the message to be transparent to the user, as is the case with SMS.

To create an MMS message, a template is typically used to specify the relative position of any multimedia elements in the message. After creation, the message can be sent either to a phone number or email address. The message is sent to the user's MMS server, which either sends it to a phone (via a notification message) or converts it into a multi-part email and sends it to the recipient's email account.

From a business perspective, MMS services could look very much like the i-mode service from NTT DoCoMo. For example, NTT DoCoMo earns about 10% of the total revenues from the i-mode services, and the content provider earns the rest (see www.mobileimode.com for more information). Thus content providers could do quite well in the MMS marketplace. The content providers could provide still images such as photos, postcards, presentations, business cards, autographs, letters, telegrams, telexes and greetings cards. Entertainment could be another major content provider. In fact, many of the PC features and utilities (e.g., screensavers and plug-ins) could migrate over to the mobile phone, too.

The content of MMS messages has been defined by the MMS Conformance Specification version 2.0.0 written by the MMS Interoperability Group. This group consists of representatives from CMG, Comverse, Ericsson, Logica, Motorola, Nokia, and Siemens. The MMS specification uses SMIL (Synchronous Multimedia Interaction Language) for the presentation format. SMIL is an XML-based standard from W3C that defines how the multimedia elements are coordinated.

A great deal of information about MMS is available over the Web. Here are some key sources:

http://www.mobilemms.com

http://www.openmobilealliance.org

http://www.3GPP.org

http://www.forum.nokia.com/

http://www.ericsson.com/

2.3.5 Applications of Messaging in m-Business, m-Government, and Mobile Life

Wireless messaging services typically consist of:

- Basic email for mobile devices
- SMS text messaging
- Unified messaging
- Alerts and notifications to be sent and received by mobile devices
- Multimedia messaging services (future)

In business settings, many of these services are used regularly because they lead to improved productivity of employees, sales force, and field force (employees in the filed such as repair technicians). Different types of messaging services are popular in different parts of the world for business as well as personal use. SMS is extremely popular in Europe (being called the killer mobile application); Blackerry is quite popular in the US; and MMS is gaining popularity in Japan due to i-mode.

Very interesting applications of messaging services can be found in m-government. The State of Kentucky has initiated a Wireless Messaging Service (WMS) – an extension of the state's Enterprise Shared Services Messaging Infrastructure that provides messaging services to over 35,000 employees in agencies throughout the state. The WMS solution involves a RIM wireless device, Blackberry software, and a Cingular wireless data network. In Singapore, "Mobile Service via SMS" allows library users to check accounts, renew items, pay outstanding fees/fines and receive reminders to return items. As another example, after the September 11 attack and the anthrax problems, all members of the US House of Representatives were issued a BlackBerry device to facilitate communications between members and appropriate authorities in case of an emergency. As yet another example, at the height of the SARS incident, the Hong Kong government sent a blanket text message to 6 million SMS users to warn against rumors and explain government plans.

Time to Take a Break
✓ Overview and Mobile Messaging Services
M-Commerce, M-Portals, M-CRM, M-SCM
Specialized Mobile Applications and Examples

2.4 Mobile Commerce – Buying/Selling Through Mobile Devices

2.4.1 Overview and Examples

m-Commerce describes the phenomenon of using mobile devices such as digital phones and PDAs to search the Internet, access data and information, and conduct purchasing or business transactions. m-Commerce is fueled by the extreme popularity of mobile devices. However, a large proportion of the usage continues to depend on laptops and PCs, which may remain the de facto standard of devices used to access enterprise data and applications. Although the mobile PDA and telephone device markets are growing rapidly, the growth in the North American market is slower than in the European and Japanese markets.

Here are some examples of m-commerce:

- In Europe and parts of Asia, you can use your mobile phone to dial a special number on a vending machine and obtain a beverage. The same technology can let you call a bank or brokerage firm and trade stocks.
- The Norwegian mobile operator NetCom has piloted four m-commerce service offerings: a popular daily soap opera, a pizza delivery service, an online newspaper archive, and a location-based service.
- Text message marketing, based on SMS-based marketing promotions, is an important part of m-commerce. Many companies are specializing in this area. See, for example, the Text marketer website (www.textmarketer.co.uk).
- Purchases of stocks or goods from Amazon.com are possible using a mobile device. And many companies use the Internet for advance-ticket sales. Now these tickets can be bought from a mobile device.

- Wireless access to the Internet to surf the Net for bargains is becoming common. People can look for bargains while waiting in the doctor's office, having their car serviced, or on a fishing trip.

m-Commerce is a competitive business. To stay in this business, companies need to provide more user-friendly, efficient, and secure transactions than their competitors. They may also need to include digital wallet services, ease of navigation, security, and context-relevant services. Another value-added service is handling of billing (see the sidebar, "Billing for M-Commerce – A Thorny Issue").

What is needed to make m-commerce a reality? Here are some ideas:
- Wireless networks. At present, 3G and Bluetooth are two top contenders.
- Middleware such as Wireless Application Protocol (WAP)
- Innovative new applications that are unique to mobiliy – for example, positional commerce (see next section)
- Wide use of handset devices to conduct business

Why m-Commerce? The wireless Internet has many features that permit mobile interactive services to be more personalized than traditional Internet applications.
- Mobile telephones are carried by their owners almost everywhere and kept switched on most of the time (especially in Europe, where mobile users aren't charged for incoming calls). Consumers can thus not only gain access to wireless services wherever there is a network presence, but also keep tabs on time-critical information, such as stock market reports or urgent messages.
- Wireless-network operators – at least those using the GSM standard – are uniquely able to determine the identity of a user. Since mobile telephones are not usually shared, and a personal-identification number often protects them, the telephone itself can be used as a means of identification.
- Operators can detect a user's exact location, enabling a whole range of new applications.

Let us look at online buying/selling to understand the implications and opportunities for mobile computing. Online purchasing includes consumers, buyers, and suppliers engaging in online trade and includes links to back-end systems for inventory updates and credit checking. As shown in Figure 2-6, the purchasing process consists of several steps that can be viewed in terms of pre-purchase, purchase consummation, and post-purchase activities. In the pre-purchase activities, the users browse through various sites, compare prices, and select the online merchants they want to buy the goods from. Naturally, the use of handheld devices can have the most profound impact on these activities. The main issue is how the content is displayed on small devices with small display units. In the purchase consummation activities, the user may use a shopping cart and place an order by using a payment system. Naturally, the payment systems should work with mobile devices in this activity. The post-purchase activities involve the classical "back-end" systems that handle settling of payments, shipping and receiving, etc. Many of these applications are legacy applications that have been around since the 1970s and 1980s.

m-Commerce involves a large number of systems that allow mobile users to search company catalogs for certain price ranges and then place orders for chosen product(s) through mobile devices. Needless to say, all these activities must be conducted securely through mobile devices over wireless networks. In addition, the order processing, inventory control, payment, and shipping/receiving systems are employed. All these systems need to work together to satisfy the demands of mobile buyers and sellers. Due to this demand, several specialized middleware services are needed to support mobile computing and online purchasing. These services are also being packaged with other infrastructure services to form ***"Middleware***

Platforms" that support mobility and ecoomerce**.** Examples of these platforms are ***Mobile Application Servers*** such as IBM's Websphere and Microsoft's Internet Commerce platform. These platforms are an area of tremendous activity and are discussed in Chapter 4.

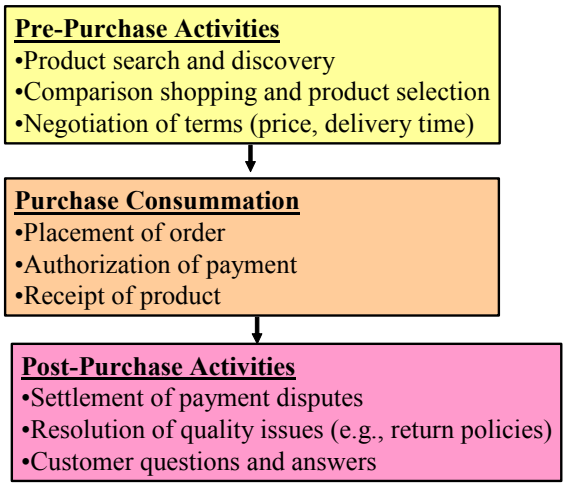


Figure 2-6: Purchasing Steps

Billing for m-Commerce – A Thorny Issue

Billing for third-party products and services in m-commerce is a difficult issue. The main problem is that if you buy a service by using your telephone, then can the telephone company be billed for the purchase? But there are legal restrictions on the legality of billing for non-telecom-related charges in different countries. For example, in Europe and parts of Asia, you can use your mobile phone to buy a beverage – your phone bill includes the charge. But the beverages cannot be charged to your telephone service in the US at present (in the US, telephone carriers can only charge for telephone related services). There are additional questions also: how will the collection of payments work, and who will handle customer care and dispute resolution?

Different approaches are possible. First, the purchases are made only through credit card and the phone carrier only charges for the wireless access services, not the value of the transaction. For smaller transactions, cellular providers may provide digital wallet or digital cash. Another possibility is that all billing, payment collection and customer care is handled by a third party.

2.4.1.1 Web Storefronts and Virtual Shops for Purchasing

Mobile commerce can be conducted through a variety of models. Web storefronts and virtual shops are the main alternatives. In both these cases, mobile access has been added as another capability.

Web Storefronts. Web storefronts use the Internet to market and sell products and services to a global audience of customers. Web storefronts are limited to one seller, i.e., they enable a seller to use the Internet to differentiate its product offerings, enhance customer service, and lower marketing, sales, and order processing costs. For example, a shoe store can develop a Web storefront that allows customers to purchase shoes over the Internet. As shown in Figure 2-7, storefronts support Web-based purchasing systems that allow users to search company

catalogs for certain price ranges and then place orders for chosen product(s). This represents online buying/selling through a catalog using a shopping cart, electronic wallet, or similar tool. It includes both consumers purchasing goods and online buyers purchasing goods from a supplier. It can also include links to back-end systems for inventory updates and credit checking.

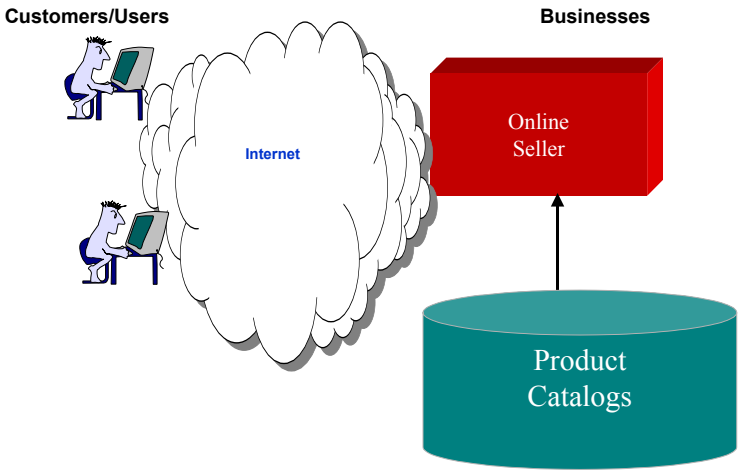


Figure 2-7: Online Purchasing Through a Storefront

A very large number of Web storefronts currently exist. Examples are:

- Staples.com – for buying office supplies online
- E-Bay – for buying numerous products
- Shop.com – for buying groceries
- Flowers.com – for buying flowers

Storefronts basically show a company's presence on the Web and are usually based on a product catalog that shows product features, price, expected delivery time, etc. These Web-based sales solutions deliver process and cost improvements to sellers but they are very "supplier-centric." These supplier-centric solutions can complicate efforts of customers to control expenditures and maintain preferred supplier relationships. For example, you may have to visit several storefronts to find a bargain.

Virtual Shops. Virtual shops go a step beyond the Web storefronts by providing a storefront that represents several back-end sellers. In other words, the restriction of a single seller is removed. For example, Amazon.com supports the purchase of books by tying several bookstores together. Enterprises that support virtual operations are known as "virtual enterprises" or extended enterprises. Basically, a ***Virtual Enterprise (VE)*** is a network or loose coalition of a variety of value-adding services in a supply chain, that unite for a specific period of time for a specific business objective, and disband when the goal is achieved. Examples of virtual enterprises, in addition to Amazon.com, are:

- Drugstore.com – for buying drugs online (many partners)
- Virtual Parts Supply Base (VPSB, http://www.vpsb.com/) – supplies hard-to-find parts for the US government
- The National Industrial Information Infrastructure Protocols (NIIIP) Consortium – develops inter-operation protocols for manufacturers and their suppliers (for more information on NIIIP see http://www.niiip.org).

Virtual enterprises can be customized, if needed, to reflect a buying organization's unique trading agreements, workflow, and business rules. These virtual procurement channels, also known as *e-procurement*, enable a self-service purchasing environment that pushes product selection and order initiation to the desktops of frontline employees through a common Web browser. Many early e-procurement solutions were intranet-based applications that did not fully leverage the ubiquity of the Internet. As a result, many e-procurement solutions are now transitioning to e-markets. Many unique issues in virtual shops and virtual enterprise arise. An example is customer care.

2.4.2 Variants of Mobile Commerce – Positional and Voice Commerce

Voice and positional commerce are becoming value-added features to m-commerce. Figure 2-8 shows a simplified view of variants of mobile commerce that includes C2B as well as B2B operations. The sellers provide wireless access to the main catalog and the order processing system. However, payment and inventory control systems are also involved in purchasing. In addition, the items not available at the seller can be provided by the other suppliers through their own catalogs and purchasing systems. Positional information can be useful in this context because if a user is calling from Boston, perhaps the Boston suppliers could be given a preference to save on shipping costs.

Figure 2-9 takes a closer look at a positional and voice commerce applications. The wireless and wired devices (with and without GPS support) are connected to a Feature Server that consults a GIS (Geographical Information System) map for GPS support. The Feature Server also does interactive voice response, voice recognition, and speech generation. The Voice Portal provides voice menus or directories for users to select or traverse services. Based on this information, the back-end applications are accessed. These applications may reside in the Application Server that provides various transaction services (e.g. shopping carts, form requests) or may be part of a trader network.

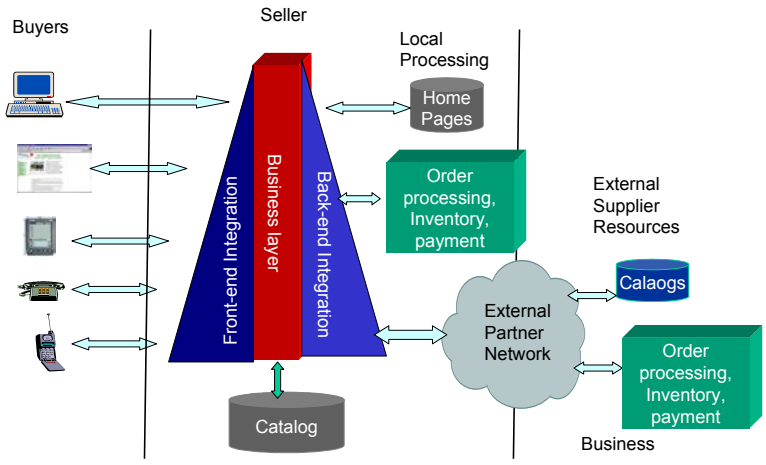


Figure 2-8: A Simple Internet-based Purchasing System

An interesting example of PV (positional and voice) commerce is the "Commotion" prototype, developed at the MIT Multimedia Laboratory. This prototype captures the sites you visit most frequently, e.g., your home, your office, your grocery store, and your bank. Then the items most relevant to the site where you are at present (or close to) are

automatically retrieved and "spoken" to you. For example, if you are driving by the grocery store, the system will remind you that you need to buy groceries.

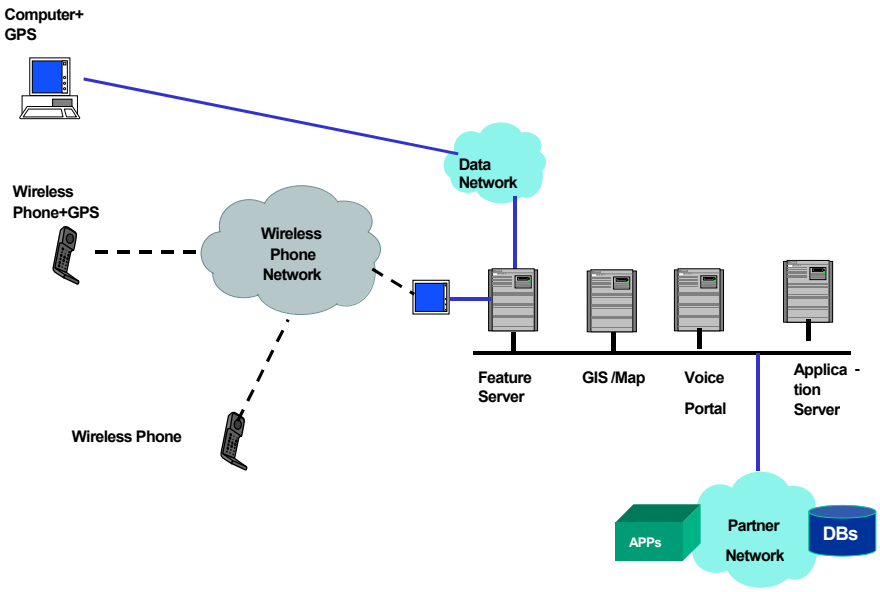


Figure 2-9: Positional and Voice Commerce

2.5 Mobile Portals

2.5.1 Overview and Examples

A mobile portal is a consolidated information channel for mobile customers. A variety of mobile portals have been created in the last few years. Here is a sample [Kalakotta 2002, Barnes 2003, Evans 2001]:

- DoCoMo in Japan is probably one of the best-known examples of mobile portals. The content providers allow millions of wireless users to access a wide range of content from i-mode cellular phones. We will look at i-mode in a later chapter.
- America Online's AOL Anywhere makes AOL services universally available on a wide range of mobile devices including cell phones and TVs.
- Several companies such as Boeing's "connexion" are trying to bring email and Web browsing to airline passengers. These portals in the sky will allow passengers to access their email and surf the Web while airborne.
- AT&T Wireless and other companies are creating voice portals where customers speak instead of click to obtain the information and services they need.
- GM offers a mobile portal called Virtual Advisor. This portal, built on a Hughes Electronics cellular and satellite system, offers voice-activated news, traffic information, email messages, and stock quotes over the Web.
- American Express has created a mobile portal to give cardholders a real-time and comprehensive view of their finances – accessible through wireless devices. The financial

information is aggregated from cardholder relationships with banks, brokerages, mutual fund companies, and others.
- Starbucks is creating mobile portals in its coffee-houses so customers can browse the Net through their wireless laptops and PDAs.

2.5.2 What are Portals?

Since m-portals are extensions of portals, let us briefly lok at portals. Simply stated, a portal is a website that serves as a doorway to a specific topic – they are intermediaries that offer an aggregated set of services for a well-defined set of users. Portals are reasonably popular in modern enterprises (they were very popular circa 1999). The oldest and perhaps still the best-known portals are the Web search engines such as Yahoo and Lycos that allow users to search the websites for information. Over the years, the portals have evolved into websites that offer, in addition to Web searches, a broad array of resources such as email, forums, online shopping malls, and personalization tools. Advanced portals combine Web documents, databases, applications, visualization tools, search engines, integration technologies, speech recognition, and natural language processing to give users an integrated view.

A mobile portal, as we will discuss later, includes a set of integrated programs designed to make it easier for a mobile user to find information and, if needed, to conduct business or personal interest activities (e.g., shopping, setting up meetings, chatting). In addition to mobility support, these programs typically offer at least the following core features (see Figure 2-10):
- Web searching and Web advertising (e.g., home pages, banner ads, etc.)
- News about the topic of your interest
- Reference tools and specialized assistants ("wizards") to help with your chores (e.g., scheduling meetings, calendaring, video conferencing)
- Access to online shopping venues and, if needed, to back-end systems and services
- Some communication capabilities such as email, chat rooms

The purpose of all these integrated programs is to provide convenience, and a sense of community to the user, and to help make the user feel more comfortable about using the portal for the purpose of beginning his/her journey. So in this sense the portal is offering a valuable time-saving service. Of course, the purpose of the portal builder is to make sure that you conduct *all* of your activities by using the portal, thus capturing your "behavior" that could later be used for marketing. By offering visitors a portal to a specific topic, the portal vendor can control the results the user gets when he/she searches for a keyword. The links returned are the links that the portal vendor wants to return. By virtue of the free community-building tools such as email, chat and forums, it also gives the visitor a way to communicate with the portal owner and ask questions and make comments about a specific topic. The advantage to the vendor, of course, is that by addressing these questions and comments, it gives the vendor an opportunity to become a trusted expert on a specific topic. Once a portal community has been established, then many suppliers may advertise on your portal about their product or service that relates to the community. This not only produces revenue for the portal vendor but again offers a valuable service to the visitors that keeps them returning to the portal site.

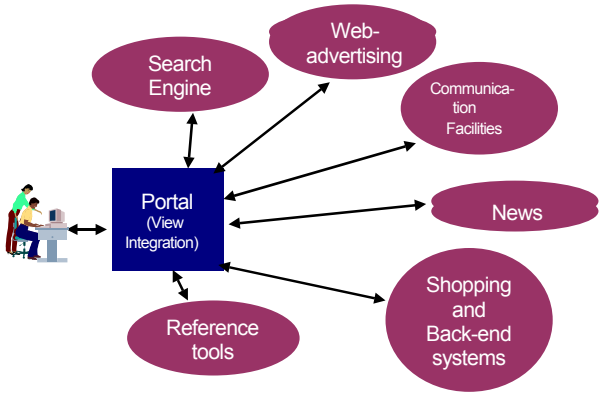


Figure 2-10: Conceptual View of Portals

2.5.3 What Are Mobile Portals? – A Closer Look

A mobile portal, as stated previously, is a repository with a set of integrated programs designed to make it easier for a mobile user to find information. In addition, these portals help wireless users to conduct business or personal interest activities such as calendaring, setting up meetings, chatting, shopping, etc.). Wireless technologies make portals into an on-call 24/7 service. Consider, for example, a physician that is paged to pay attention to a patient. Using a handheld device, the physician accesses an HMO (Healthcare Maintenance Organization) portal and pulls the patient information over a secure link. Similarly, a small business owner while traveling overseas gets a call from his secretary saying that some overdue taxes notice was served to the company main office. He accesses a small business portal for help with his taxes from his handheld device.

Mobile portals can generate additional cash flow for several industries. To generate increased revenue, mobile portals must offer the ease of use and seamless functionality that improves the customer's quality of life. To be financially profitable, mobile portals must offer customers what they want, when they want it, and at a price that they accept. The key features are constant connectivity, time-sensitive information, location awareness, and ease of access to information accessed through mobile devices.

Mobile portals are of two types. First are the portals that *contain content* about wireless and mobility. For example, www.thinkmobile.com is a portal for mobile users – it is a large repository of reports, case studies, and analysis of value to mobile users. Another example is the www.mobileinfo.com site – a large repository of reports, articles, products, and case studies about mobility. The others, of main interest to us, are the portals that are *accessed* through mobile devices. An example is the Mazingo Mobile/Wireless Portal (http://www.mazingo.net/mobile) that provides over 1200 sites formatted specifically for small-screen devices. Numerous other mobile portals exist. Some of these portals allow voice interactions, thus they are voice portals. In addition, positional information can be used. For example, a positional portal for weather will only show you the weather in the area that you are in.

Naturally, conversion of existing Web portals to MVP (mobile, voice, positional) portals requires a great deal of work in conversion and delivery of the content to appropriate devices. Many consulting companies provide these services. For example, the HP Mobile Portal Solution is a consulting-led solution that delivers the software infrastructure, portal framework, mobile applications and the delivery team required to deploy mobile portals. The

portal solutions usually portal component applications, from simple Web page displays to complex sequences of business events like location sensing, event notification, billing, and messaging. Business components employing Java, XML, and Visual Basic based on J2EE and .NET are usually employed in such solutions by consulting organizations.

What Mobile Portals Can Provide

The following content provided by the portals can benefit from wireless access and result in increased revenues, entrance into new markets, improved quality and higher customer loyalty:

- Product and service information
- Travel reservations
- Advertising
- Alerts and notifications
- Remote monitoring
- Personal information management (PIM)
- Location-based services
- Telematics
- Wireless gaming

2.5.4 Classes of Portals Accessible from Wireless Devices

Portals accessible from wireless devices can be, as shown in Table 2-3, Internet-based or enterprise-based. Internet portals provide uniform access to the information on the Internet, while enterprise portals provide a similar uniform access to the information systems and processes of an enterprise. In addition, portals can be directed to horizontal or vertical markets. For e-business, the enterprise portals are of particular interest. These portals are usually aimed at employee productivity and can be designed for employees and contractors, for customers, or for trading partners. An example of enterprise portals for trading partners is the GM/Commerce One alliance that ties together more than 1000 partners. In fact, enterprise portals are beginning to look a lot like the emarkets that we will discuss later. Access to these portals from wireless devices increases the customer base for the business and value to the customer. Let us review these portals in a little more detail:

Table 2-3: Taxonomy of Portals (Source: Gartner)

	Horizontal	Vertical
Internet-based	Eyeball aggregators such as Yahoo, Infoseek, Lycos	"Vortals" such as eBay, CNET, Ivillage, E-LOAN, E*TRADE, Sportsline
Enterprise-based	Horizontal Enterprise Portals such as Verticalone	Enterprise Portals such as Space.com, WebMD, and VerticalNet

Eyeball Aggregators (Mega/Super) Portals. These are Internet portals that provide horizontal aggregated services. Known as eyeball aggregators or "Mega/Super Portals," these portals originated as the Internet search and navigation tools. Examples of these portals are Yahoo, Lycos, AOL, and Infoseek. Initially, the Internet Portals provided a "window" from which users could find and view desired content. However, they have evolved into powerful sites that offer a wide array of online resources and services such as personalization services, communities of interest, free email and chat rooms, and direct access to specialized functions, such as shopping networks, auctions, and online trading sites. The Internet portals are becoming MegaPortals due to consolidation.

Vertical Portals. Vertical portals, also known as "Vortals," focus on a specific industry or community, and were the fastest growing segment of Internet portals. Vortals provide the same core functionality as Internet portals, but are targeted to a specific industry or niche:

- aggregation of relevant content
- links to related industry, supplier and even competitor sites
- community and collaboration capabilities
- e-commerce services for products and services relevant to the industry

Examples of vertical portals include telezoo.com in the area of telecommunications, cnet.com for computer-related technologies, webmd.com in healthcare, and many others. Verticalnet.com is an interesting vortal for several vertical marketplaces. In addition, vortals such as eBay and E*TRADE are popular for auctions and trade.

Enterprise Portals. Enterprise portals, also known as corporate or transaction portals, provide a door into an enterprise's information, applications and processes. Enterprise portals personalize and aggregate the corporate computing resources primarily for its employees. In some cases, enterprise portals are built for the customers and partners. The focus of enterprise portals is on improving the productivity of its employees; thus they provide work-related aids that may include conducting business transactions. Typical enterprise portals provide a personalized view, based on the role of the employee, of the following services:

- access to applications and transactions needed by the employee to conduct work
- information retrieval tools
- PC desktop services
- communication services such as email, instant messaging, voice over IP

For example, an enterprise portal for financial analysts may provide facilities for stock analysis, trading, and settlements, in addition to the email, fax, news, calendaring, and video conferencing services. Enterprise portals can provide integrated applications access, information management, and knowledge management within enterprises as well as between enterprises and their partners, suppliers, and customers. At the time of this writing, enterprise portals are starting to integrate enterprise resource planning (ERP) systems, such as SAP and PeopleSoft, through thin client access such as mobile devices. These portals are also providing support for mission-critical operations. This includes support for application integration, process and workflow management, and aggregation of resources (information, applications, services, communities) relevant to the context or task being performed.

An extensive discussion of portals for e-business can be found in the book by M. Davydov, *Corporate Portals and e-business Integration*, McGraw-Hill Professional Publishing, 2001.

2.5.5 Mobile Portal Architectures and Software

Many software packages are becoming commercially available for development and deployment of portals. Examples include Brio Technology's Brio.Portal (www.brio.com) and

Sterling Software's EUREKA:Portal (www.sterling.com). These packages typically include facilities for uniform user access, administration, publishing, and integration with back-end systems. Most of these packages are providing wireless access as an added feature of portal software. Although many portals at present use large HTML files that contain information from a variety of sources (content providers), the content is converted to be displayed on mobile devices. The customers access the portal content through handheld devices and browse information based on certain browsing rules. In practice, however, the portals may also directly connect with remote content providers through an integration layer. Figure 2-11 shows such an architecture. According to this architecture, the front end of a portal must be able to handle a multitude of mobile users and devices while the back end must be able to communicate with multiple content providers. The middle tier provides the content consolidation and can use the customer profiles to customize the presentation.

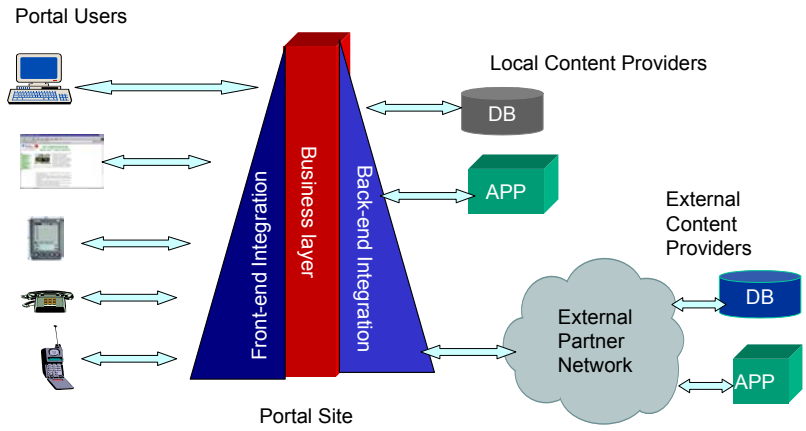


Figure 2-11: High Level Architecture of Portals

2.6 Mobile Customer Relationship Management (M-CRM)

2.6.1 Overview and Examples

Mobile CRMs are intended to identify, attract and increase retention of profitable customers, by managing relationships with them on a 24/7 basis through mobile devices. Here are some examples:

- SpeechWorks International teamed with Quixi to develop a mobile CRM. This CRM is a speech application that combines call center and voice recognition capabilities for enterprise sales staff. At present, 50 to 80 percent of CRM implementations fail because entering sales data is time-consuming and expensive. To attack this problem, speech recognition technology plays an important role in M-CRM. Quixi has also added other functions such as user authentication, speaker verification and text-to-speech technology to its speech recognition. The speech application also includes live sales support representatives to facilitate interactions between sales staff and their corporate CRM platforms.
- Siebel CRM concentrates on solving the day-to-day problems of mobile salespeople using the applications. For example, an outbound salesperson wants to focus on customers, not administration. Seibel developed applications that combine product

catalog and pricing and configuration technology to help generate an accurate quotation for a client that could be accessed wirelessly by the sales rep while on-site.

- Many companies have joined hands (e.g., HP and Compaq, SAP and Palm) to build M-CRM. The alliance is marrying Palm's handheld computers to SAP's mySAP.com e-business system, allowing mobile users access to their SAP systems from any Internet-connected Palm device. These users can access the SAP CRM system through Palm devices.
- Dell Computer has deployed its Premier Page Program to over 5,000 corporate customers. The program, also available through mobile devices, allows Dell to enhance its successful direct-sales practices by leveraging the Web to offer a hybrid solution combining enhanced order management capabilities (product configuration, personalized pricing, order status, and shipment tracking) with customer relationship functionality (contact information, document repositories, real-time access to customer/technical assistance). The returns are quite good: Dell reports that approximately $5 million worth of Dell PCs are ordered daily via Premier Pages and account for nearly 40% of Dell's daily online revenues. Further, customers report higher satisfaction levels and intentions to make Dell their sole source for PCs.
- Boeing PART Web is a catalog of repair parts, price, inventory level, order and delivery for authorized customers only. These customers can use mobile devices to access this information. The main driver for this effort is competitive edge – repair parts are also available from OEMs, not only from Boeing. The pricing for a customer is based on its contract with Boeing.
- Telenor Mobil, via its Online Dealer extranet system, allows 1,300 dealers and 10,000 users to begin a two-way electronic dialogue, including order entry with Telenor. The Telenor system allows dealers to sign up customers instantly by using mobile devices.
- AMP Electronic Connector, Inc. (http://connect.amp.com) uses Web-based online catalog and sales for CRM. The site supports 142,000 registered customers from 145 countries; two-thirds of those are engineers. The catalog contains 90,000+ components with 3D-models, specification charts, and design drawings. The search engine is multilingual. Questions can also be submitted via email and mobile devices.

For ongoing developments, examples, and case studies in mobile CRM, see the following:

- www.crm-forum.com – This site contains news, product announcements, and a library of products and literature.
- www.crmcommunity.com – This site has a very large number of papers and reports on CRM.
- zdnet.com/techupdate/ – Good for trends and technical updates on CRM.
- CRM Guru (www.crmguru.com) – A good site for tutorials on CRM.

2.6.2 What is a CRM?

Simply stated, *Customer Relationship Management (CRM)* is "a management approach that enables organizations to identify, attract and increase retention of profitable customers, by managing relationships with them," (Source: "CRM Strategies," Ovum Report, 1999). CRM systems are an outgrowth of the traditional customer care systems that concentrate on customer loyalty through improved service and communication. The average firm loses 10% of its customers each year due to poor service, and sales personnel can spend up to 40% of their time coordinating and managing major account interactions – stealing time from revenue-generating activities [Aberdeen-CRM 2000]. As products and services become harder and harder to differentiate, CRMs have become a source of revenue, profitability and value. A study conducted by Andersen Consulting in the Telecom industry found a direct link

between CRM improvement and financial improvement of surveyed companies – CRM performance accounts for 50% of the companies' return on sales. The sidebar "How Important is Customer Retention?" lists some of the regularly quoted numbers about the importance of customer retention. Even if you do not believe all these numbers, the overall message is quite clear.

At present, CRM has evolved into a collection of methodologies, software, and Internet capabilities that help an enterprise manage customer relationships in an organized way. CRM applications, often used in combination with call centers, data warehousing, and e-commerce applications, allow companies to gather and access information about customers' buying histories, preferences, complaints, and other data so they can better anticipate what customers want and need. For these reasons, ***data mining*** has become a cornerstone of CRMs. The main idea is to analyze the customer data to discover desirable as well as undesirable behaviors, symptoms, and trends. A great deal of work on data mining for CRM is being done at present (see, for example, "Building Data Mining Applications for CRM" by Alex Berson, and the Knowledge and Data Discovery Conference proceedings).

CRMs typically consist of a database of customers with sufficient details that can be used by management, marketing, and work force (technicians, service representatives) to:

- Assess customer satisfaction/dissatisfaction and match customer needs with product plans and offerings.
- Determine what products a customer has purchased to identify best customers, develop effective marketing campaigns, and generate quality leads for the sales team.
- Improve telesales and streamline existing processes (for example, taking orders using mobile devices).
- Form individualized relationships with customers and identify the most profitable customers for highest level of service.
- Provide employees with the information and processes necessary to know their customers and understand their needs.

CRMs must meet the needs of modern customers who access the company through emails, call centers, faxes and websites. These customers demand immediate response and a personalized touch. Meeting their needs places new demands on the enterprise. Since traditional enterprise resource planning applications did not include a customer management aspect, CRM was the logical next step.

The current focus on keeping customers coming back is much more intense than the customer satisfaction efforts of the 1970s. The customer satisfaction initiatives often ended with a common means of *measuring* customer satisfaction – not necessarily a means of *improving* customer satisfaction. CRM is also broader than the age-old principle that "the customer is always right." Instead, CRM assumes that not all customers are always right – it helps you to identify the classes of customers that need different levels of attention. In other words, CRM concentrates on providing optimal value to "optimal" customers. It is obvious that the customers make buying decisions based on more than just price – their buying decisions are based on their experience that includes product and price, but also includes sales, service, recognition and support. For ongoing customer loyalty and value, companies must consider all these factors (i.e., price, product quality, service, and support).

2.6.3 What is a Mobile CRM – A Closer Look

Mobile CRM needs to address some specific issues that set them apart from the regular family of CRMs. Specifically, they need to focus on two principal users:

- The customers

- The sales reps

Support for mobile customers. M-CRM should enhance value for the customer money and value for the customer time. p-Commerce, or location-based commerce, can enhance these two values by providing information to the customer that saves her time and money. for example, while driving in an area, the sales in the area could be sent to you and if you respond you get special discounts. Examples and issues in customer focus for M-CRM are [Kalakotta 2002]:

- Mobile marketing can be used to acquire, retain, and enhance customers. SAP uses handheld devices to get customer feedback and collect buying and future customer lead information. This is done in the SAP annual conference called SAPPHIRE. Each attendee is given a wireless-enabled Palm device that he/she uses to keep track of the sessions, demos, and keynote speeches attended. The attendees also enter the feedback and issues in the handheld device. This information is later used by SAP to determine possible leads, provide follow-on product information, or email selected presentations.
- Mobile devices provide a very convenient way of capturing customer feedback. For example, Taco Bell used "mystery shoppers" who would go to different Taco Bell restaurants and buy food and pay for it just like everyone else. The only difference is that customers would take note of quality of food, quality of service, attitudes of staff, and general look and feel of the restaurant. These customers used to fill a form that was turned in, typed, and entered into a computer for processing – a long process. The mystery shoppers now use handheld devices to note their observations and transmit them wirelessly to Taco Bell's system by simply pressing a button. This allows the company to quickly analyze, identify, and react to any trouble spots.
- Mobile customers can determine status of their orders and reported problems by using mobile devices. UPS, for example, allows mobile customers to query the status of their parcels by using mobile devices, thus increasing customer satisfaction.
- Mobile coupons are sent to the interested buyers to entice them to buy new products. The buyers can use these coupons to get discounts when they actually purchase the products. For example, CompUSA uses mobile coupons to boost in-store sales. The customers view CompUSA adds and click on mobile coupons for a $20 discount on purchases. The customer has to take the handheld device into the store for verification before getting the discount.

Support for Mobile Sales Force. M-CRM needs to focus not only on administration but also on supporting mobiles sales representatives. Many wireless CRM projects tend to focus on administrative applications that – unlike mobile sales – do not deliver bottom-line value to a company's operations. Mobile sales representatives use voice and positional information effectively to generate sales and have special requirements for information synchronization. Mobile CRMs should:

- Concentrate on solving the day-to-day problems of mobile salespeople. Siebel has extended its CRM applications to pay special attention to its outbound salesperson by combining wireless and voice technologies to generate an accurate quotation for a client while on site.
- Use wireless devices to receive information in either voice or data format. A practical application would allow someone who is traveling from meeting to meeting in the car to request information by voice.
- Exploit voice support as much as possible. As stated previously, 50 to 80 percent of CRM implementations fail because entering sales data is time-consuming and expensive [Eklund 2002]. To attack this problem, speech recognition technology plays an important role in M-CRM.

- Integrate the field representative activities with the company's call centers so that a sales rep can simultaneously obtain contact information and be connected to the customer or prospect by support personnel.
- Support field reps with handhelds to interact with account management, contact management, opportunity management, activity tracking and expense reporting modules of common CRM systems.
- Support user authentication, navigation and data retrieval, speech recognition, speaker verification and text-to-speech for secure and quick interactions.
- Pay special attention to synchronization of mobile workers' laptops with the latest CRM data stored on the company servers. For example, the corporate office must have timely field intelligence collected by mobile professionals, and similarly, a field service rep might have a question about availability of a certain item at the corporate warehouse. This synchronization should take minutes and not hours. The massive downloads and uploads should be minimized in favor of selective information transfers by using online access to CRM databases and selective downloads/uploads from mobile devices.

For more details, see Eklund, R. "Mobile CRM Comes of Age," http://www.destinationcrm.com, July 15, 2002.

How Mobility can Help Customer Relationship Management

CRM systems can benefit from wireless access and result in increased revenues, entrance into new markets, improved quality and higher customer loyalty. The particular functions impacted by mobility are: :

- Advertising and marketing campaigns
- Sales force automation (SFA) functionality
- Order entry and order status
- Customer service and support
- Field force automation (FFA) functionality
-

2.6.4 Technologies and Architectures

Technically speaking, designing M-CRMs is similar to designing many mobile computing applications. The specific issues to be considered for M-CRM design include the following:

- Information access and exchange issues from different mobile devices, i.e., what information needs to be shared, in what form, with whom and under what type of controls. The different form factors and display capabilities of mobile devices need to be considered.
- Communication process management issues, given the complexity of inter-team communications, communications rules (i.e., who manages the communications flow between and among teams) and communications tracking. SMS, MMS, and other messaging services can be extremely valuable for a mobile sales team.
- Transaction management issues such as what is currently on order, what is the delivery status, and what are the open issues. Once again, SMS could be used in some of these areas.

CRM software is currently provided by vendors such as Siebel, Vantive, and Clarify along with ERP vendors Baan Co. and Oracle Corp. Most of these vendors are adding mobility as

another dimension to their products. A conceptual view is presented in Figure 2-12 in terms of the typical layers (presentation, business logic, and integration). Most vendors include at least the following elements:

- **Wireless and Wired Web**: The most important use of the Web from the CRM perspective is self-service, so customers can make inquiries about their accounts any time from anywhere. The Web (wireless + wired) should also be used for Electronic Bill Presentment and Payment (EBPP), so customers can see what they owe and pay online if appropriate. For revenue-enhancement, companies can also provide instant messages to be used for cross-selling and up-selling services based on the profiles of customers using their website.
- **Short Messaging Services (SMS) and Interactive Voice Response (IVR)**: SMS, or other types of messaging services, play an important role in M-CRM. An IVR system is required for customers to do self-service inquiries via the phone instead of the Web.
- **Call Center Technology**: Some type of call center technology with PBX or VoIP (Voice over Internet Protocol) integrated with mobile devices and intelligent call-routing is crucial for interfaces with the live customer service representatives.
- **Business Rules**: Business rules are needed to ensure that any transaction with the customer is processed in an efficient manner. For example, if a company wants the most profitable and high-volume customers to be serviced by experts, the business rules should clearly define what those criteria are. Based on the complexity of transactions, an organization may need hundreds of business rules.
- **Customer Database:** This contains the complete customer information that includes customer profile, products bought, complaints filed and issues raised by the customer, and any other pertinent customer data.
- **Integration framework**: A technology framework that allows all the applications and databases that have customer information to be integrated can make a big difference in implementation.
- **Additional Databases, Data Warehouses and Data Mining:** Managing relationships with the customers depends on customer information, which is usually in various disparate databases. You can access these sources through the integration technologies or develop a data warehouse. Consolidating the relevant information in one place and making sure that the information interrelates is not an easy task. Once done, however, data warehousing augments a company's revenue potential and customer service. For example, a company can segment the types of customers it has in the data warehouse and launch a marketing campaign geared toward specific types of customers. Similarly, good data warehousing can help in presenting the information based on certain business rules to help in cross-selling and up-selling to customers calling for other reasons. Data mining of customer data (e.g., what they have bought, when) and Web mining (e.g., mining of clickstreams that show what Web pages the customer visited before he/she bought something) are an essential aspect of contemporary CRM systems.

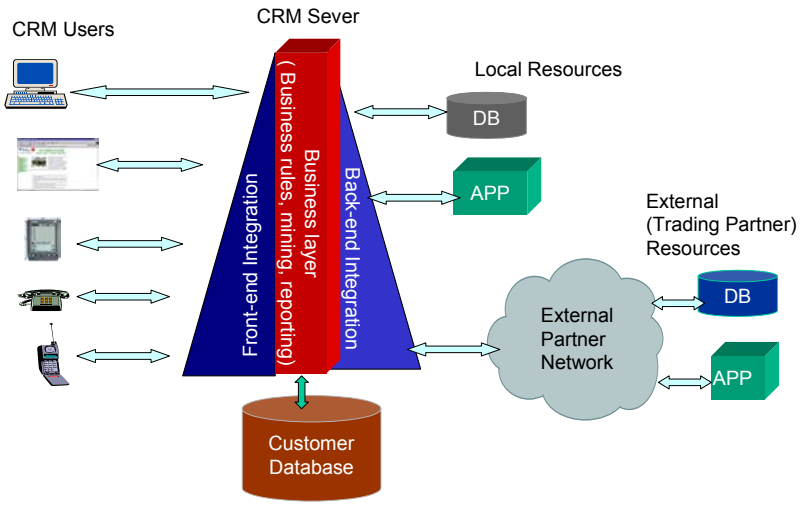


Figure 2-12: High-Level Architecture of CRM

Companies must allow customers to interface with them from any touch point that they are comfortable with – i.e. mobile devices, traditional Web, IVR, phone, or in-person meetings. Over-use of technology for the sake of technology can backfire and is potentially devastating. An appropriate combination of technology and people is the key to success.

2.7 Mobile Supply Chain Management

2.7.1 Overview and Examples

Mobile systems and wireless technologies can have a profound impact on supply chain management and B2B trade. In particular, wireless systems can add the element of real-time capture, display, and analysis of supply chain activities such as procurement of materials, inventory and warehousing, and distribution of products to the customers. The following examples illustrate a few mobile supply chain management applications and commercially available products.

- Handheld bar code readers are a norm in many industries to collect inventory, customer purchasing, and shipment information. Grocery stores such as Kroger regularly use handheld bar code readers to track inventory. Inventory tracking is an expensive undertaking for most stores because items on shelves are counted at least twice a year. This can cost between $20,000 to $30,000 – if counted and recorded manually – for a single store. The expected expenses are very high for Kroger with 150,000 stores. Handheld barcode readers with wireless connections detect and update the inventory items at the corporate servers, significantly saving time and money.
- Keeping track of items in transit while going through different stages of a supply chain is an important issue for most companies. The problems are especially acute when items have to be shipped between different companies in different countries. UPS, FedEx, and US Postal Services have all exploited wireless devices extensively to keep track of shipments. The case of US Postal Services is especially interesting because unlike UPS and FedEx, the US Postal Services do not own jet planes to carry shipments. Instead, they rely on a variety of third-party companies to move items. These handoffs are numerous

and error-prone. Handheld scanners, supplied by the Postal Services with wireless connections, are used by the third-party companies to scan the items at various points and send messages to the Postal Services corporate center.

- Phase Forward has developed a wireless application to record real-time patient information in clinical trials. Clinical trials are used by pharmaceutical companies to test new drugs. The tests are conducted on patients who typically live in different areas. The patients are expected to record their results in forms periodically after taking the prescribed drugs. But the patients usually forget to fill the form at the right time. This application uses an online form from a handheld device that captures the patient feedback and ships to the interested research groups with time stamps, etc.
- mySAP Supply Chain Management (mySAP SCM) provides support for mobile users so that suppliers, manufacturers, distributors, and retailers can collaborate in real time. Mobile access to supply chain participants provides instant access to all aspects of supply chain from supplier to sales force, from shop floor to shipper, and from warehouse to customer. Support for mobile business means visibility is increased as information flows from bar code to palmtop to enterprise systems.
- Oracle Mobile Supply Chain Applications (MSCA) enable operators to perform many common warehouse and shop floor transactions and inquiries from any location in the manufacturing facility through the use of handheld devices, PDAs, and lift-truck-mounted radio frequency (RF) scanning devices. It provides real-time interfaces to Oracle Applications through simplified user interfaces designed for the mobile worker. The MSCA product allows users access to the system from anywhere they have RF network coverage.
- AvantGo offers a variety of solutions to mobilize many supply chain applications. AvantGo M-Business Server is a mobile software platform that can mobilize an entire supply chain management process including Material Resource Planning (MRP), warehouse management, and delivery and transportation to retail operations. For example, AvantGo Mobile Delivery™ is a customizable packaged software application that reduces logistics costs and improves driver productivity. AvantGo Mobile Delivery enables a) data collection at the point of activity for workflow automation (bar code scanning, enforced work rules, error checking, and electronic signature capture) and b) route management for wireless and offline access to data and applications and seamless transition between the two.
- PEAK Technologies offers multiple solutions to integrate mobile data capture for SAP R/3. It offers pre-configured bar code-enabled SAPConsole transactions, business process analysis, certified project management and SAPConsole integration services. For those customers that require functionality outside the scope of SAPConsole, PEAK offers its SAP-certified integration solution for mobile data capture – PEAK S/3 Interface with fully integrated R/3 printing functionality.

2.7.2 What is a Supply Chain Management System?

A *supply chain* is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Suppliers, distributors, manufacturers, and resellers play different roles in supply chains (see Figure 2-13). Supply chains exist in both service and manufacturing organizations. Naturally, the complexity of the chain may vary greatly from industry to industry and firm to firm. For example, the supply chain for a small vegetable store may be very simple (buy the vegetables from farmers directly and sell them) but may be long and complex for a national food store. In large-scale

manufacturing industries, the supply chain may involve dozens and even hundreds of partners.

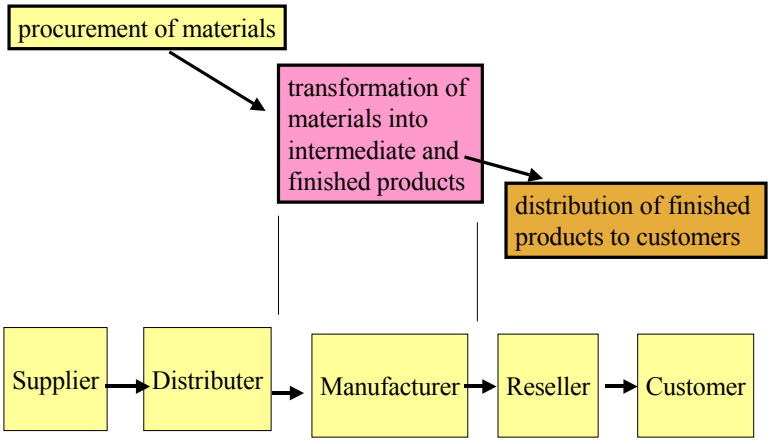


Figure 2-13: Conceptual View of Supply Chains

Supply chains and supply chain management approaches have been around for centuries. Over the years a large body of research and know-how in supply chains has been accumulated and can be found in several text books and magazines (see the sidebar on "Supply Chain Management References" for a small subset). Detailed discussion of SCMs is far beyond the scope of this book. We quickly give some background information about supply chain decisions and models and then concentrate on how the Internet and e-business are fundamentally changing supply chains.

2.7.3 Supply Chain Decisions and Models

Before discussing mobility, let us discuss the decisions that are made at strategic (i.e., for longer time horizon) and operational (i.e., day-to-day shorter time horizon) levels in supply chains. Many of these decisions, as we will see, are impacted by mobile devices and wireless networks. The following major decision areas in supply chain management occur both at strategic and operational levels [Ganeshan 1995]:

- **Location Decisions** that determine the location of purchasing, manufacturing and distribution facilities. Although location decisions are primarily strategic, they also have implications on an operational level.
- **Production Decisions** include what products to produce, and which plants to produce them in. These decisions also include allocation of suppliers to plants, plants to distribution centers (DCs), and DCs to customer markets.
- **Purchase Decisions** that include what to buy, where to buy it from, and how to transport the purchased items to DCs and final centers.
- **Inventory Decisions** refer to means by which inventories are managed to buffer against any uncertainty that might exist in the supply chain (i.e., keep inventory of items in case some materials do not arrive in time).
- **Transportation Decisions** that determine how the items are transported around the supply chain. These decisions are closely linked to the inventory decisions, since there is a tradeoff between inventory cost and transportation cost (you can keep large inventories to minimize transporting items on an as-needed basis).

These decisions, as stated previously, can be at strategic and operational levels and require different types of information models. The information models show the players in the supply chain and what information they consume/produce throughout the supply chain. The models for strategic decisions are typically large and require a considerable amount of information because strategic decisions try to integrate various aspects of the supply chain. Often, due to the enormity of information requirements, strategic information models provide approximate solutions to the decisions they describe. The operational decisions, meanwhile, address the day-to-day operation of the supply chain. Due to their narrow perspective, these models often contain a considerable amount of detail and provide very good, if not optimal, solutions to the operational decisions.

In addition to strategic- and operational-level decisions, some intermediate-level decisions may also need to be made in practice.

These decisions and information models, as we will see, are being greatly influenced by the Internet economy and e-business. For a more detailed discussion of design aspects of supply chains, the reader should review available textbooks in this area (e.g., *Introduction to Supply Chain Management*, by Handfield and Nichols, Prentice Hall, 1998; and *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*, by Simchi-Levi and Kaminsky, McGraw-Hill, 1999).

Mobile e-Marketplaces

Many industries buy and sell products and services through public or private electronic marketplaces. Continuous communication with these marketplaces is needed to gather pricing information, news and events, order status, bid status, approval requests, and sales histories. Wireless access to private or public electronic marketplaces provides a solution to this need for this continuous communication. A common example is that of being alerted to bidding events such as an outbid notification during an online auction. Wireless access to the marketplace is an essential tool for many emarket transactions. In particular, real-time personalized alerts based on trading events such as order status can improve the overall performance of the electronic marketplace.

2.7.4 What is Mobile SCM?

Mobile technologies can revolutionize the supply chain by supporting anytime, anywhere access to information. By using mobile technologies, supply-chain participants can reach new levels of visibility and productivity by improving the following decisions:

- Location decisions can be aided by employing handheld devices to capture, in real time, location of purchasing, manufacturing and distribution facilities.
- Purchase decisions can be aided by point-of-sales terminals and location-aware mobile devices that can find the cheapest materials quickly.
- Inventory decisions are especially impacted by the large number of handheld bar code readers that can read goods at hand and update inventories in real time through wireless connections.
- Transportation activities can be monitored through detectors and barcode readers that capture the item movements as they are transported in various stages.

The result is a rapid, more accurate data collection, enhanced information distribution and portability, lower cost of ownership, improved quality of service, and a higher level of customer satisfaction and loyalty. Specifically:

- Automated data capture by using sensors and other mobile devices at different points in the supply chain replaces error-prone manual input. The decision makers have the information they need wherever they happen to be.
- Mobile devices give all supply chain participants instant access to the information they need. Beneficiaries are the customers, suppliers, sales force personnel, shop floor attendants, shipping clerks, and warehouse supervisors.
- The principle participants (suppliers, manufacturers, distributors, and retailers) can collaborate in real time by using mobile devices and wireless communications.

In essence, an automated mobile supply chain solution can reduce errors that result in incomplete and inaccurate data collection. By adopting an automated system using mobile devices, firms can have continuous visibility of their complete logistics process. M-SCM provides an easy way for companies to track and confirm delivery, warehouse, and manufacturing information.

2.7.5 Mobilizing Supply Chain Management

It is important to establish a technology strategy for SCM that supports multiple levels of decision making and gives a clear view of the flow of products, services, and information. An information technology system is needed that integrates capabilities at three levels:

- For operational decisions, the system must be able to handle day-to-day transactions and e-commerce across the supply chain and provide instant information on orders and daily scheduling.
- For mid-term decisions, the system must facilitate planning and decision making, supporting the demand and shipment planning and master production scheduling needed to allocate resources efficiently.
- For strategic value, the system must provide tools, such as an integrated supply chain network model, that synthesize data for use in high-level "what-if" scenario planning to help managers evaluate plants, distribution centers, suppliers, and third-party service alternatives.

Unfortunately, the information that most companies require urgently to enhance supply chain management resides outside of their own systems. This is precisely where mobile devices connected over wireless networks can play a major role. Internet connectivity through wireless creates opportunities to change the supply chain fundamentally. For example, support for mobile business means visibility is increased as information flows from barcode to palmtop to enterprise system. In addition, common warehouse and shop floor transactions and inquiries from any location in the manufacturing facility can be conducted through mobile devices. More importantly, data is collected at the point of activity. Thus workflow automation (bar code scanning, enforced work rules, error checking, and electronic signature capture) can be done on the spot. But wireless Internet and mobile devices are not the only players in M-SCM. The following additional technologies are also changing the SCM landscape:

- Traditional Internet by providing direct links between supply chain players around the globe
- Web and XML by providing access and interchange between supply chain players
- EDI for handling orders between large companies (EDI is an older technology but still used heavily in SCM)

- ERPs (Enterprise Resource Planning) systems that provide access to resources throughout an organization
- Enterprise application integration (EAI) platforms that make it easy for companies to integrate with a diverse array of suppliers, resellers, manufacturers, and customers

Collectively, these technologies are changing the existing/old model of SCM to the new model where the suppliers communicate with the consumers in fewer steps (see Figure 2-14).

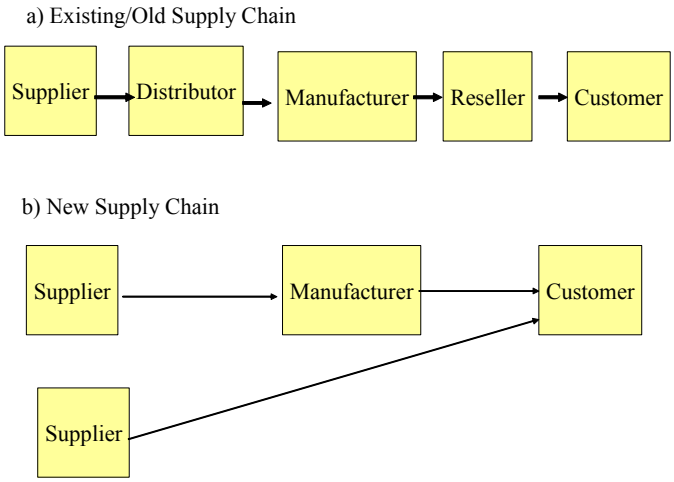


Figure 2-14: Old Versus new Models of Supply Chain

2.7.6 Concluding Comments about Mobile Supply Chain Management

The supply chain can benefit from wireless enablement in several processes, including purchasing, manufacturing, distribution, and customer service and sales. Different types of mobile technologies have been used in supply chains and have typically consisted of bar code scanners for improved data capture and asset management. In particular, handheld devices with Palm OS and Windows CE operating systems connected with wireless LANs and wireless WANs offer extensive opportunities for monitoring the supply chains at almost all points. Newer systems are also using wireless sensor networks to detect any damages to the goods during transit and to alert the receivers and the senders for appropriate action.

Supply chain management systems require many activities such as incident reports, inventory management with and without just-in-time considerations, picking up and delivering orders with receipt confirmations, proof-of-delivery notification, logistics tracking and inspections, quality control, vendor performance monitoring, warehouse management, asset management, and alerts and event notification. Many of these can benefit from wireless access, resulting in increased productivity of trading partners and employees, cost reduction through improved quality and reduced inventory, and customer satisfaction.

Time to Take a Break
✓ Overview and Mobile Messaging Services
✓ M-Commerce, M-Portals, M-CRM, M-SCM
Specialized Mobile Applications and Examples

2.8 Special Mobile Applications (LBS, WSN, RFID)

Several specialized mobile applications for specialized purposes are also being developed. Let us look at mobile agents and wireless sensor networks as examples.

2.8.1 Location-Sensitive Applications

Many location-sensitive applications, also known as location-based services (LBSs), are being developed at present. Examples of these applications in m-business and m-government are:

- Search for the most relevant information according to your location – e.g., "I am looking for a shop within 5 miles of my home," "what movies can I see in my neighborhood and how far will I have to travel," and "find the nearest hotel and check what else there is in the neighborhood."
- Display maps and calculate routes based on where you are located. In addition, you can improve transportation of goods by locating the nearest pick-up point and planning routes based on real-time traffic situations; or by reporting alerts in case of changing traffic patterns, and adjusting the route.
- Some limousine companies are tracking their cars and can detect unauthorized off-route vehicle stops or off-route activities – for example, if a limo driver calls and says that he is at the airport but the LBS can show that he is at home (technology is not always good!).
- Advertising and notification services relevant to the user's location. For example, if a particular area has been declared hazardous, SMS messages could be sent to the citizens in the area.
- City Guides can be shown with location of nearby historical structures/buildings, government offices and interactive commercial services if you are in certain part of the city.
- Permit requirements can be obtained based on location. For example, permits for digging in an area with underground pipes or cables can be obtained easily. LBS also makes it easier to obtain a drilling permit in a rural area and to register the associated filings with ground water districts and natural resources/environmental entities.
- Insurance risk analysis can be conducted based on locations. Tools such as Where@Risk, for example, provide a match of location to the appropriate risk criteria that can be used by insurance adjusters to develop policies.

There are some additional developments worth mentioning in this regard. The Telephone Number Mapping Working Group of the IETF is defining a DNS-based architecture and

protocols for mapping a telephone number to a set of attributes (e.g. URLs) that can be used to contact a resource associated with that number.

There are numerous applications that are driving the developments of LBS. The mobile operators are expecting significant revenues by offering a number of location-based services such as positional commerce. Location-sensitive information can be bundled into mobile commerce and other application as a value-added service. Regulatory agencies are also requiring mobile operators to provide accurate locations for emergency purposes and public safety (e.g., the E911 support).

To meet these demands, a wide range of techniques for location management have been introduced. The oldest and by far the most commonly used technique is based on cell ID (i.e., a cellular user is located by the cell she is in). Other techniques include Assisted Global Positioning System (AGPS), Angle of Arrival (AOA), and variants of time taken (these techniques estimate distance by determining the time it takes for the signal to reach the user). These techniques yield different location accuracy (typical ranges are 50 meters to several kilometers). We will discuss these techniques in Chapter 5.

While LBSs can provide valuable capabilities to support mobile applications for business as well as government initiatives, they also raise additional privacy concerns for general public use. In essence, an LBS database can have a complete log of what locations you visited in a day and how long you stayed at each location. Naturally the benefits need to be balanced against the privacy concerns.

2.8.2 Wireless Sensor Network (WSN) Applications

Sensors are small devices that can be used to measure temperature, humidity, motion, color changes in a painting, or any other measurable thing. These sensors, also called motes, are installed in particular locations or can be "sprayed" in a particular area to gather information. Sensors by themselves are not very powerful -- they just sit around and collect information. The real power of sensors comes wireless sensor networks (WSNs) which are formed when these tiny sensors start communicating with each other through wireless. WSNs can shuffle the information collected through thousands of sensors and transfer it to the public Internet or a corporate LAN. The information can finally be collected at a control point where it can be analyzed (Figure 2-15). Although most WSNs consist of very small processors communicating over slow wireless networks, WSNs can be used in several situations.

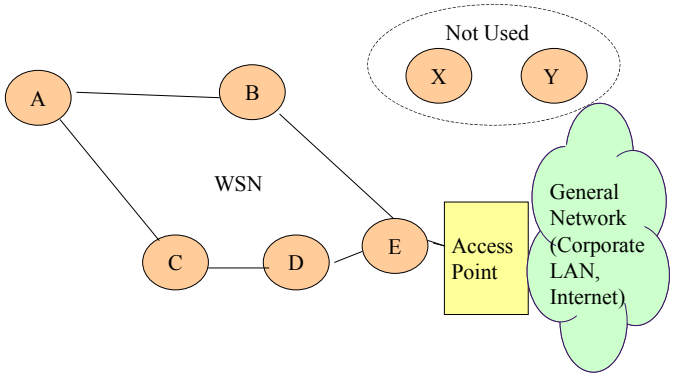


Figure 2-15: A Sample Wireless Sensor Network

Thousands of tiny low-power sensor devices are typically spread over large areas to form WSNs in many practical applications. The sensors of WSNs collaborate with each other to

monitor the environment, guide vehicles, and detect faults in buildings and bridges. Some of the examples are:

- In many military situations, sensors are "sprayed" in a battlefield or an enemy area to detect and record certain activities and send information back to control centers for analysis and appropriate action.
- WSNs are being considered as an alternate to landmines where the sensors can detect enemy vehicles. This is much safer than landmines, which stay long after the conflict is over and are hazardous to the people living in that area. In contrast, sensors are harmless after conflict because they simply sit around collecting useless data until their batteries die. See the case study in Chapter 7.
- WSNs are also being used in medical situations for patient monitoring. For example, patient heart rate and blood oxygen levels are monitored by sensors. This information is gathered from different patients and sent to the PDA of an attending physician [Jovanov 2001].
- WSNs are being used in supply chain management systems also. For example, Sears Canada has completed an experiment that uses WSNs to detect if an item is damaged on transit before the customer gets it.
- WSNs are also used to detect temperature fluctuations, earthquakes, automobile speeds, and cattle activities in fields. Many civilian applications of WSNs have been developed and deployed. See [Szewczyk 2004] for application of WSNs in habitat monitoring.

WSN applications need specialized platforms. These platforms, discussed in more detail in Chapter 4, provide a hierarchy of services that range from low level sensors to higher level data aggregators, and data storage and analysis capabilities (see [Hill 2004]).

We will review WSNs in Chapter 7 and examine the technical foundations of WSNs in Chapter 10. See the June 2004 issue of CACM for a survey of WSNs.

2.8.3 RFID Applications

RFID (Radio Frequency Identification) systems have been used in a variety of applications. An RFID system typically consists of the following components:

- A tag or label that is embedded with a single chip computer and an antenna. The antenna is so small that it can be printed on the tag with carbon-based inks. RFID tags (chip plus antenna) are also called "transponders." The tag is somewhat similar to the commonly used bar code labels. However, an RFID tag has more intelligence. Tags are of two types. "Passive" tags, the type of tags commonly used in retail stores and supply chain systems, pick up enough energy from the radio to operate and to communicate back to the radio. "Active" tags have an embedded battery and offer the advantage of longer-range communications and can communicate with other tags. In this case, a WSN can be formed between the RFID tags.
- A short range radio (e.g., a wireless LAN such as Bluetooth) that communicates with the tag. The radio receiver is usually an RFID reader, or detector/interrogator., that gets the information from the RFID tag and then may send it to a back-end system for processing. An RFID system's "read range" — the distance a tag must be from the detector/reader — varies from a few centimeters to tens of meters, depending on frequency used, whether a tag is active or passive, and the type of antenna used on the reader.

In many practical applications, an RFID reader transmits a wireless signal to the RFID transponder, which responds in milliseconds with a unique identification code sent to the reader. The reader sends this code to the host system for processing. RFID is being used increasingly instead of the old bar-code systems because unlike bar code-based tracking

systems, an RFID system can read the information on a tag without requiring line of sight and without the need for a particular orientation. That means RFID systems can be largely automated, reducing the need for manual scanning. In addition, RFID tags hold much more data than the bar code labels.

In many areas, RFID-based passes are used in highway toll booths for automobiles. For example, in New Jersey, an EZPass system is being used heavily on the NJ Turnpike. An EZPass is bought and is pasted on the front windshield of a car. When the car approaches a toll booth, it slows down so that the RFID reader on the toll booth can read the EZPass number. As soon as this is done, the reader posts this transaction to a database and then gives a signal to the toll booth that gives the green light to the automobile. The auto owner gets a monthly bill from EZPass for all the transactions. This whole process takes less than a minute – usually the car just slows down. In the older manual system, an auto driver gets a toll ticket when she gets on the NJ Turnpike, then before exiting, the driver stops, takes out her ticket, gives it to the toll booth attendant, pays the attendant, and then leaves. This may take several minutes. Similar systems are operational around the globe at present.

Many airlines are using RFID for airline baggage tracking. For example, British Airways has trialed a paper label-based RFID transponder. Each luggage has an RFID tag that is read by the RFID readers as the luggage moves on the belts. By using this system, more than 225,000 pieces of luggage were transferred successfully between airport hubs from Manchester and Munich to London's Heathrow Terminal 1 with 100% accuracy. RFIDs are also used in tracking valuable assets. Unique RFID tags are installed on the asset and can be detected by RFID readers. If stolen, law enforcement agencies could be informed of the RFID serial numbers. For highly valuable assets, this information can be used for random checks at ports and other exit points within a country, thus preventing the asset from leaving the country.

Additional information about RFID can be found at www.rf-id.com.

2.9 Mobile Agent Applications

2.9.1 What are Mobile Agent Applications?

Mobile agent applications represent a different class of applications in which the application programs themselves are mobile. Most of the mobile computing applications discussed so far use mobile devices over, typically, wireless networks. But the application code itself does not move around – it either resides on the handset, the back-end system, or both. In case of a mobile agent applications, mostly implemented through Java code, the application code may itself migrate from the back-end system to your handset and then move to another site.

Mobile agents, as stated in Chapter 1, are programs capable of being transferred to remote hosts in order to carry out different tasks on behalf of their users. Mobile (transportable) agents have the ability to travel through the network and carry out a set of operations on behalf of a user (customer) -- they do so with some degree of autonomy to satisfy its user's goals. A mobile agent can halt its execution, move to another host on the network while maintaining its state, and resume execution on the destination host. Mobile agents are also typically intelligent, known as mobile intelligent agents (MIAs), and thus have the ability to learn, use knowledge effectively, and adapt to new situations. An example of mobile intelligent agents is a ***"shopbot"*** that moves around a trading network to shop on our behalf

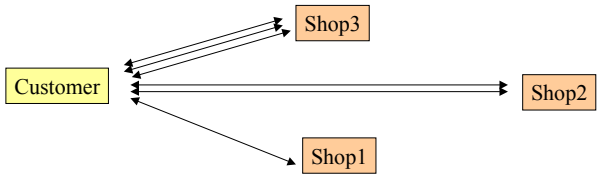
by using certain level of intelligence in looking for bargains. Thus a mobile intelligent agent is typically:

- *Transportable:* moves from one site to another
- *Knowledgeable:* has knowledge of a domain (e.g., insurance) and user needs
- *Self-learning:* can acquire additional knowledge from different situations
- *Pro-active*: takes initiative; sets and pursues goals
- *Autonomous*: decides what to do without external human intervention
- *Timely*: does not spend forever deciding what to do next
- *Persistent*: remembers a "lifetime" of activity
- *Social and communicative*: interacts with other agents

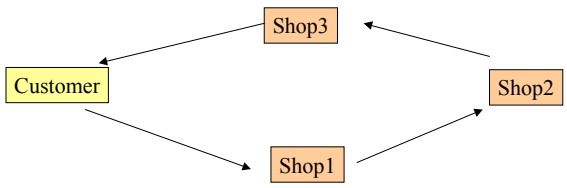
On a personal note, I have a love-hate relationship with the term "agent". Over the years, too many mediocre programs have been marketed as agents -- basically anything that can make any decision has been positioned as an agent. However, the idea of mobile intelligent mobile agents is alluring for ecommerce because we do need software entities that can roam around the Web space making intelligent decisions on our behalf. My yardstick includes intelligence and mobility as the two key attractive features.

2.9.2 Mobile Agents Versus Client/Server Model

Mobile agents basically provide an alternative to the very common client/server model. In a client/server model, the clients send the data to the program sites (servers) and receive the results. In a mobile agent model, the program is shipped to the data sources -- it thus travels from one data source to the next, collects the results, and sends the results back to the originator. Figure 2-16 illustrates the differences between client/server and mobile agents by using a shopping example. Suppose you wanted to find a cheap computer. quickly. In the client/server model, the customer issues calls to different shop sites, in some cases multiple calls are issued to the same shop, and the results are sent back to the customer after visit to every shop site. In a mobile agent model, a "shopbot" is sent to the first shop where it checks for the desired computer. It then moves to the next shop (carrying the results from shop1). After shop2, the shopbot moves to shop3, carrying the results from shop1 and 2. The accumulated results are sent back to the customer after shop3.



a) Shopping by using a Client/Server Model



b) Shopping by using a Mobile Agent Model

Figure 2-16: Mobile Agent Versus Client/Server Model

Which model is better. Well, it depends. First, let us consider the network considerations. The client/server (C/S) model assumes a sustained network connection to carry the requests and responses. If numerous network calls need to be issued to a server, then the C/S model consumes a great deal of network resources. On the other hand, the mobile agents migrate from site to site and do not consume network bandwidth to carry multiple request/reply packets. Mobile agents are particularly suited for wireless networks because they do not need a sustained network connection, i.e., the customer can ship an agent and disconnect -- it can later connect to receive answers. Second, let us consider the programming complexity. In the C/S model, the intelligence is at the client machine because the decisions are made at the customer location. On the other hand, mobile agents have to carry a great deal of intelligence with them -- they basically accumulate results and roam around the network making decisions on behalf of the customer. Mobile agents can decide dynamically where and when to travel to a particular destination site based on some embedded mobility metadata to perform some required work.

Mobile agent technologies grew out of three earlier technologies that have attempted to address the limitations of the classical RPC (remote procedure call) model of C/S systems. These technologies include process migration where the entire address space is moved from one site to the next, remote evaluation programming where only the needed program (not the entire address space) is shipped from one site to the next, and the mobile objects where the executable code and data with state information are shipped from one site to next. See [Wong 1999] for a detailed discussion of these variants of mobile agents. In general, the current mobile agent technologies are outgrowth of mobile object systems, mainly Java, through refinements and addition of capabilities such as autonomy and intelligence (mobile objects may or may not be autonomous or intelligent).

2.9.3 Sample Applications of Mobile Agents in Mobile Computing

Although the mobile agent technologies have been around for a while, real life applications are relatively sparse. We have already discussed shopbots that are mobile intelligent agents which go around and shop on your behalf. Mobile agents are suitable for wireless networks. For example, an agent can move from site A to site B in a wireless network, disconnect from the wireless network, do local processing at B, then connect to the network for migrating to site C, disconnect, etc. This cycle of process, connect to migrate, migrate, disconnect, and process can be followed as the mobile agent goes around the network. This will work well in a slow wireless network.

Let us consider a more detailed example of this.

A company that needs to order office supplies could use agents ("inventory agents") to monitor the quantity and usage patterns of office supplies within the company and launch buying agents when supplies are low. The buying agents can roam around the network, automatically collecting information on suppliers and products that fit the company needs. They can also decide which suppliers and products to investigate in detail, negotiate the terms of transactions with selected merchants, and finally place orders and make automated payments. In this example, the inventory agents may or may not be mobile but the buying agents should be mobile.

Other but similar applications of mobile agents in Ecommerce are:

- Personal agents to go around the network to collect and present information to you in the way you want it (e.g., sort the sites you want to visit in terms of historical significance)
- Mobile automated negotiators for retail e-commerce, bandwidth trading, subcontracting for manufacturing, electronic trading of financial instruments, and vehicle routing among

independent dispatch centers. These automated hegotiations can be conducted from a cellular phone through mobile agents. The cellular phone just invokes a mobile agent, disconnects from the network, and the mobile agent hops around the network (wired or wireless) negotiating on your behalf.

- Collaborative agents that can serve as the mediators in manufacturing supply chains. These agents can monitor the status of supply chains, detect delays, and find alternative sites in case of failure/unacceptable delay of a supplier. Supply chain systems of this type are proactive in nature and are known as "Zero Latency Supply Chains" because they can detect and correct problems without any delays (hence zero latency).
- Multi-agent systems for large scale trading and brokering that involve many local agents (some static, some mobile). Local agent managers handle local agents and multi-agent systems handle multiple local agent managers. Examples of multiagent systems can be found in the energy market where multiple energy suppliers can have their own local agents coordinated by multi-agent systems and the manufacturing segment for manufacturing resource planning. For discussion and examples of multi-agent systems, see the Communications of ACM special issue on this topic, May 1999.

2.9.4 Mobile Agent Requirements

Mobile agent systems must satisfy the following requirements:

Portability. Mobile agent code itself must be portable; when an agent arrives at a server the server needs to be able to execute that agent. Commonly used computer languages such as C and C++ are not very portable. Compiled C code only works on the machine it was compiled for and the source form is notoriously unportable. Portability can be achieved by running computer programs inside virtual machines interpreters, but overhead has limited the use of interpreted languages. Most mobile agent systems under development now rely at least in part on virtual machines to standardize the execution environment.

Ubiquity. In order for mobile agents to be successful they need access to many different computer resources. Servers for agents must be commonplace; there needs to be a widely accepted framework for executing mobile agents deployed on many machines across the Internet. In practice the requirement of ubiquity means that the execution environment needs to have market acceptability, be freely available, and be unencumbered by restrictive intellectual property requirements.

Network Communication. Mobile agents that live in the network need to be written in a language that makes network access simple. It must be easy to transfer objects across the network and to invoke methods of remote objects. Traditional computer languages treat networking structures as an afterthought, usually providing only a minimal socket library. Languages that better support network access have typically not been widely used. This situation is improving with the current development of language-neutral distributed object frameworks such as CORBA.

Server Security. A major concern specific to mobile agents is the protection of the servers running the agents. Running arbitrary programs on a machine is dangerous: a hostile program could destroy the hard drive, steal data, or do all sorts of other undesirable things. This risk must be thoroughly addressed if mobile agent environments are to succeed. Two types of security are possible to protect servers from malfunctioning and hostile agents: physical and social.

- Physical security refers to building servers for agents in such a way that the agents cannot harm the server. The ``laws of physics" of the server execution environment can be designed to make dangerous operations difficult or impossible. Common approaches

involve creating a ``sandbox'' for visiting agents, restricting access to resources (preventing disk writes, for instance) and ensuring the agent cannot escape those restrictions. This approach to security is attractive; when it works, it is entirely effective. But the viability of physical security in the face of design complexity and server implementation bugs is unclear. In addition, physical security is typically focussed on protecting some underlying aspect of the server from the sandbox the agent is trapped in. But if multiple agents are put in the same sandbox how can the server guarantee that one agent cannot harm another? As we put more trust in the computations that take place inside sandboxes, the security of those sandboxes themselves becomes important.

- A second approach to server security is using social enforcement mechanisms to punish the creators of harmful agents. If a server administrator can find out who is responsible for a malicious agent, then that person can be held accountable via social mechanisms (such as lawsuits). Digital signature technology makes identifying the authors of agents possible. But there are limitations to a purely social approach to security. It may not be clear which agent is responsible for damage, nor will it be easy to determine ahead of time which agent authors are trustable. In practice some combination of social and physical enforcement of server security will be useful.

Agent Security. The complement of server security is agent security: whether the agent can trust the server on which it is executing. A mobile agent might contain secret information such as proprietary data and algorithms. Worse, servers might have an incentive to subvert the computation of a visiting agent. In the Internet-based DES cracking effort currently under design a major concern is protecting the computation from sites that pretend to do pieces of the problem but return false answers [Tre96]. Physical security answers to this problem are difficult. Secure, trusted hardware on the server could guarantee agent safety but is unlikely to be widely deployed. Agent programmers can protect their agents by obfuscating their code and verifying the results of the remotely-performed computation but the general applicability of these techniques are unknown. Social solutions may be possible in the form of reputation systems for servers. This area of security has largely been unexamined.

Resource Accounting. If economic control and incentive are going to be factors in net-wide resource use some mechanism to account for the resources that an agent uses and a way for receiving payment for those resources is necessary. In theory these requirements are not difficult to meet. Servers can keep track of the resource usage of agents, explicitly accounting CPU, memory, bandwidth and disk usage. Digital cash systems can be used to pay for services. In practice, these technologies are not widely deployed and the overhead they impose presents an engineering challenge.

2.9.5 Existing Mobile Agent Platforms and Architectures

Many mobile agent environments have been developed to satisfy these requirements in industrial sectors as well as the academic communities. We will list a few in Section 2.9.5.2. Although the environments vary widely, most current mobile agent environments are based on Java due to its portability and mobility features. The Java-based mobile agent environments use an architecture that is somewhat generic. We present such an architecture in Section 2.9.5.1.

2.9.5.1 Generic Architecture of Mobile Agent Environments

The Java-based mobile agent environments use an architecture that is somewhat generic. Figure 2-17 shows a generic mobile agent architecture discussed by [Wong 1999] that can be used as a framework for discussion. This architecture shows six different components:

- The agent manager is responsible for sending and receiving agents to/from remote hosts. It serializes the agent and its state before sending it to remote hosts and also deserializes and receives the agents on the other end.
- The reliability manager makes sure that the sent agent is properly received by the remote host. It also guarantees the persistence of state associated with agents.
- The security manager authenticates the agent before it is allowed to execute at the receiving host. All other mobile agent system components interact with the security manager to authenticate and authorize mobile agents.
- The application gateway provides secure interactions with external applications (non-agent) such as purchasing systems and product catalogs.
- The directory manager keeps a directory of all agents in the network.
- The inner-agent communications manager is responsible for managing communications between multiple agents that are dispersed throughout a network. . . .

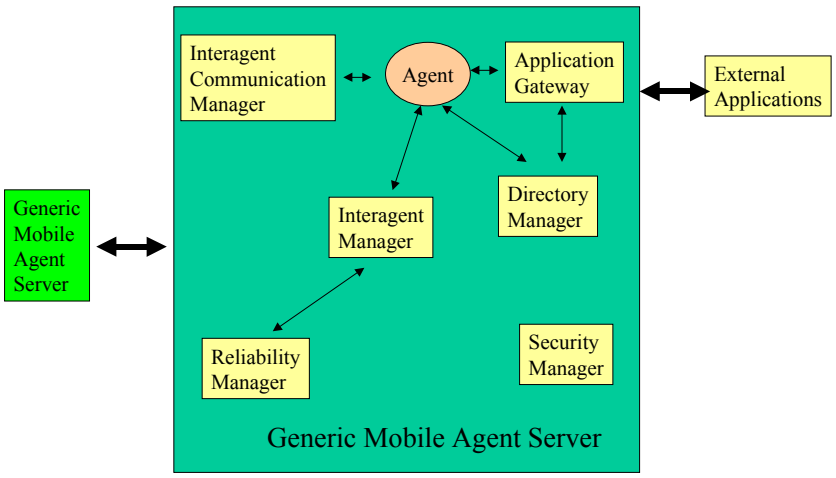


Figure 2-17: Generic Mobile Agent Architecture

An important implication of this architecture is that a mobile agent server must exist at each site where the mobile agent is supposed to run, Thus if you have a network with 100 hosts but only 7 have the mobile agent server, then your mobile agent can only roam around the 7 hosts. In addition, mobile agnt systems are not interoperable (so what is new!). Thus if you are using the Aglet mobile agent system, then the aglet mobile agents can only run at the sites where the Aglet server is running. Considerable work in multiagent systems and agent transfer protocols (ATPs) is needed to address these problems (see the Communications of ACM special issue on multiagent systems, March 1999 and ATP specification at the IBM site http://www.trl.ibm.co.jp/).

2.9.5.2 Sample Mobile Agent Platforms

Extensive lists of agent technologies (mobile as well as static) can be found at the web sites www.informatik.uni-stuttgart.de and www.reticular.com. Examples of a few industrial mobile agent platforms are:

- Aglets (**IBM Japan).** An aglet is a Java object that can move from one host on the Internet to another. The Aglet platform provides a comprehensive model for programming mobile agents without requiring modifications to Java VM or native code.
- Concordia(Mits**ubishi Electric).** CONCORDIA is a framework for development and management of mobile agent applications for accessing information across multiple

networks (LANs, Intranets and Internet). over wire-line or wireless communication. Concordia supports multiple client devices, such as Desktop Computers, PDAs, Notebook Computers, and Smart Phones.

- Gossip (**Tryllian).** Gossip is a mobile agent application that trades information on the Internet. You tell the Gossip agent what interests you and the agent travels to a server on the Internet called the Marketplace. At the Marketplace, the Gossip agent looks for other agents with similar interests. When agents with similar interests meet, they start a conversation and exchange information.
- Grasshopper (**IKV++).** Grasshopper is compliant to the mobile Agent System Interoperability Facility (MASIF) standard. The MASIF standard is built on top of CORBA, .The standardization ensures that agent applications will be open towards other agent environments.
- Jumping Beans (**Ad Astra Engineering, Inc.)** Jumping Beans is a software framework that allows developers to mobilize a Java application such that it can move from one host to another during its lifetime. The mobilized software moves from host to host, along with the executable, data, state, resources and other essential information.
- Voyager (**Object Space)** Voyager combines the power of mobile autonomous agents and remote method invocation with complete CORBA support. Voyager comes complete with distributed services such as directory, persistence, and publish subscribe multicast.

In addition, the following research prototypes at various universities are worth noting:;

- Agent Factory (**University College Dublin, Ireland)** Agent Factory is an agent prototyping environment. It is written in Smalltalk-80 and supports Web interfaces.
- D'Agents (**Dartmouth University).** D'Agents supports mobile applications that require the retrieval, organization and presentation of distributed information in arbitrary networks. Some of the research areas are security mechanisms, support for mobile and partially connected computers, and resource discovery tools.
- Agent Tcl (**Dartmouth University).** Agent Tcl is a tool for developing transportable agent systems. The transportable agents are created using the Tool Command Language (Tcl). The agents migrate from machine to machine using the jump command. Execution resumes on the destination machine at the statement immediately after the jump is completed. Migrating agents are encrypted and authenticated using Pretty Good Privacy (PGP).
- GenA (**Centre de Recherche Informatique de Montreal (CRIM)).** GenA is based on Java and allows mobile agents to run and move between other platforms such as Voyager, Grasshopper, and Aglets. Programming GenA agents is independent of the underlying agent platforms.
- Gypsy (**Technical University of Vienna).** The Gypsy Project utilizes Java for the implementation of an environment for experimenting with mobile agent programming. It is intended for application in Internet information retrieval, Internet commerce, mobile computing, and network management.
- JIAC Site (**Technische Universitat Berlin).** JIAC is an agent architecture. Implemented in Java. It offers component-based mobile agents and provides support for creating e-commerce applications and distributed telecommunication services.
- Kasbah (Agent-mediated Electronic Commerce (AmEC) Initiative Massachusetts Institute of Technology). Kasbah is a multi-agent research project to develop an agent-mediated electronic commerce system. A user wanting to buy or sell a product or service will create an agent, give it some strategic direction, and send it off into the agent marketplace. Kasbah agents pro-actively seek out potential buyers or sellers and negotiate with them on their creator's behalf

- Knowbot® System Software (**CNRI)** Knowbot® is a research infrastructure for mobile agents ("Knowbot programs") intended for use in widely distributed systems such as the Internet. The current version is an experimental prototype. The Knowbot software is written in Python but support for Knowbot programs written in Java (in addition to Python) is planned.
- Mobiware Middleware Toolkit (**Columbia University).** Mobiware is built on CORBA and Java distributed object technology. It runs on mobile devices, wireless access points and mobile-capable switch/routers providing a set of open programmable interfaces and algorithms for adaptive mobile networking.
- Mole (**University of Stuttgart). Mole** is a research project investigating mobile agents. This prototype adds mechanisms for migration and communication using the Java programming language.
- SOMA (**University of Bologna)** SOMA is a Java-based Mobile Agent framework that has been designed to achieve two main objectives: security and interoperability.
- TeamBots (**The Robotics Institute Carnegie Mellon University).** TeamBots is a Java-based collection of application programs and Java packages for multiagent mobile robotics research.

2.9.6 Mobile Agent Application Summary

While mobile agents are a useful approach to distributed computation, in practice they have not been used in many real commercial applications (most mobile agent applications are research prototypes). There are many technical challenges to implementing large-scale industrial-strength mobile agent systems. Most problems are centered around the issues of security and reliability. Basically, mobile servers must be designed, implemented, and deployed that not only allow mobile agents to run, but allow them to run safely. Another key area of work is multi-agent systems that involve coordination between multiple mobile agent systems. Mobile commerce presents an interesting area of work for mobile agents and may provide the "killer application" that mobile agent systems need so badly.

2.10 Short Case Studies and Examples

2.10.1 Frankfurt Airport Mobile Asset Management

Fraport AG, the owner and operator of Frankfurt Airport, is responsible for the continual optimization of technical systems supporting quality, security and safety measures of the airport. Fraport is required by federal law to provide proof of facility maintenance at regular intervals, thus a reliable and stable mobile asset management solution was needed. An essential element of the safety program is the airport's 22,000 ventilation units. These units, in case of fire, automatically shut down, thus slowing down the fire. The existing asset management is a paper-based system that documents maintenance checks and repair orders on air conditioning and ventilation systems throughout the airport. The paper-based system is error-prone and slow – it takes a while to collect the forms from the workers and then type them in. Another major problem is that there is no guarantee that the ventilation units (shutters) were actually checked because the workers could fill the form without doing any checking. This presented a safety hazard.

Fraport already uses SAP, so it chose to extend its existing investment in SAP solutions and selected SAP Mobile Asset Management (MAM), one of the SAP solutions for mobile business. SAP MAM extends the reach of SAP's Enterprise Asset Management solution to service engineers and technicians through wireless networks and mobile devices. The SAP MAM application uses radio frequency identification (RFID), personal digital assistants (PDAs) and integration with Fraport's existing SAP ERP suite. The RFID tags (transponders) are mounted on the shutters and each PDA has an RFID reader. Fraport anticipates reductions in facility control costs of up to 70 percent by using this mobile asset management.

Before MAM deployment, service engineers had to fill out lengthy forms during equipment checks, then enter the data manually into the central ERP software. Now, the service technicians use PDAs to access daily maintenance plans and carry out work orders. The PDAs act as clients to the ERP software for reporting and archiving – they read maintenance-relevant information from the RFID tags installed on ventilation shutters and send it to the ERP software. The mobile scenario confirms that service technicians duly check each vent on their work orders because the PDAs can read tags only at a distance of three centimeters or less. Thus a technician cannot "fake" maintenance without actually performing the act. This solution safeguards maintenance processes and generates reports in compliance with federal regulations. In addition, it helps the company maintain a complete view of the assets and quickly locate reoccurring faults.

Fraport began installing the integrated RFID and SAP Mobile Asset Management for safety maintenance at more than 400 buildings and facilities at Frankfurt Airport in November 2003. Fraport's goal is to convert the entire maintenance system into a mobile scenario.

Sources:

- SAP Info (www.sap.info), "SAP Solutions for Mobile Business," May 2004.
- R. Kalakota, *Mobile Enterprise Applications*, e-Business Strategy White Paper, Jan. 2004.

2.10.2 SMS and Receipt-Reporting for Tax Purposes in the Philippines

Like many other developing countries, tax collection has been a problem in the Philippines – almost one third of tax due is not collected by government. Self-employed professionals such as shop keepers with high incomes are of particular concern. It is not feasible to send tax examiners to go over the income tax returns of these high-net-worth individuals because it may create opportunities for corruption.

The BIR (Bureau of Internal Revenue) is trying to get the citizens used to the idea of demanding receipts for goods and services rendered. The basic motivation is that if the citizens started collecting receipts for the services from self-employed professionals, then BIR could have a more solid basis for estimating the income of self-employed people and determining the taxes due (it seems like a roundabout away, but . . .). To popularise the receipts, the BIR has launched a raffle where citizens send the receipts they've collected for a chance to win a million pesos (US$ 20,000). The raffle has been a success because thousands of people sent in their receipts. However, the BIR did not have enough people to go through the receipts for data mining and analysis. This led them to an SMS-based raffle to replace the traditional raffle.

To join the BIR's SMS-based raffle, citizens send their name and address, and the Tax Information Number (TIN) of the professional/business/commercial establishment from which they have purchased goods or services. They also supply the receipt number, and the

cost of purchase to their cellular service provider. Each text message to the BIR costs the sender 2.50 pesos (US$0.05). The program has been a great success, with monthly draws on a regular basis.

The BIR reports that around 168,000 individuals registered for the SMS-based raffle from June to October 2003. But as a single registrant can send multiple entries, there were a total of 2,775,902 entries for the said five-month period. To isolate the service providers who do not issue a receipt, the system provides taxpayers an opportunity to report stores/service providers who do not issue official receipts. In the same five-month period, the public reported to the BIR a total of 16,533 establishments/businesses/professionals who were not issuing official receipts.

Because the TINs are unique to a taxpaying service provider, and multiple receipts from a taxpayer are received, the BIR can make reasonable estimate of the yearly income of these taxpaying service providers. The SMS-based raffles are not only helping with tax compliance but are also providing the BIR with other valuable information. For instance, the BIR has caught establishments issuing non-BIR registered (hence fake) receipts because of the SMS raffle. They have also caught businesses not registered with the BIR or whose Tax Information Number (TIN) is fake.

An important aspect of this m-government system is that BIR did not have to spend any of its own money developing the infrastructure for its SMS-based raffle. The system was developed in partnership with cellular service providers and application service providers (ASPs) on a fee-sharing arrangement. The BIR is not completely satisfied with its SMS-based raffle and is planning to co-operate with other sweepstakes and raffling initiatives.

Source: E. Lallana, "SMS and Receipt-Reporting for Tax Purposes in the Philippines," February 2004. ," http://www.e-devexchange.org/eGov/topic4.htm.

2.10.3 RFID for HomeLand Security[3]

Due to the heightened security awareness, crossing borders is taking longer. Depending on the time of day and entry port, it takes from 30 minutes to 2 hours to cross the US-Canadian border. The Canada Customs and Revenue Agency (CCRA), Citizenship and Immigration Canada (CIC), US Customs and Border Protection (CBP) and US Department of Homeland Security are co-operating in a joint venture to simplify border crossings for pre-approved, low-risk travelers. The new system, called "NEXUS," has made the border crossing a matter of seconds (at least for regular, low-risk travelers). After considering a number of possibilities, US immigration officials selected an RFID-based system. First piloted at a small port in Port Huron, Michigan, the system now is being rolled out to every major trade corridor across the countries' mutual borders. NEXUS currently is operational in the Pacific Northwest, Detroit, Mich., and Buffalo, New York.

Each participant who wants to use this facility has to sign up for the NEXUS program. Each participant is fingerprinted, gets his or her photo taken and completes an enrollment form. After a background check, the participant is notified that the application has been approved and is called in for a personal interview. Successful applicants receive a NEXUS identification card about the size of a credit card. Embedded in the card are a computer chip and a tiny RFID antenna. With that card, a NEXUS program participant can access specially designated crossing lanes. Once in the lane, he or she holds the card up to an RFID reader

[3] Suggested by Gaurav Mendiratta.

positioned well in front of the inspection booth. The reader flashes the participant's photo and information onto a computer screen inside the booth. The inspector verifies that the photo on the screen matches the vehicle occupant and, if all checks out, authorizes the car to proceed. A typical NEXUS inspection takes less then 5 seconds to complete. The system seems simple, but powerful security capabilities are built in.

An RFID system's "read range" — the distance a tag must be from the interrogator in order to read the information stored on its computer chip — varies from a few centimeters to tens of meters, depending on frequency used, whether a tag is active or passive, and how directional the antenna is on the interrogator.

More than 50,000 people are enrolled in the program so far, and the enrollment centers are processing applications quickly. The NEXUS program has dramatically cut crossing times for enrollees, and it has helped ease the workload of border agents already stretched by newly tightened security requirements, giving them more time to spend on higher-risk activities. The result is a system that is of benefit to both border inspectors and NEXUS participants.

References

- http://www.intermec.com/eprise/main/Intermec/Content/About/getCaseStudy?section=about&ArticleID=981
- http://epsfiles.intermec.com/eps_files/eps_wp/radiofrequency_wp.pdf
- http://www.customs.ustreas.gov/xp/cgov/travel/leavingarrivinginUS/how_do_i/nexus.xml
- http://www.cbsa-asfc.gc.ca/E/pub/cp/rc4209/rc4209-e.pdf
- www.ezpass.com/static/info/howit.shtml
- www.howstuffworks.com

2.11 Concluding Comments

Mobile computing applications support m-business, m-government, and mobile life initiatives. Within the business context, mobile computing applications provide wireless access to business intelligence, customer relationship management, sales force automation, field force automation, and supply chain management. These m-business applications are being used to increase employee productivity and are being followed by applications that are offered to customers, partners, and suppliers. In this chapter, we have discussed the core mobile computing applications that are being used for m-business and m-government initiatives. Examples of these applications are wireless messaging services, mobile portals, mobile commerce, mobile customer relationship management systems, mobile supply chain management systems, and specialized applications involving mobile agents and sensor networks. These applications drive the enabling technologies such as mobile computing platforms and wireless networks – discussed at some length in the following chapters.

2.12 Suggested Review Questions and Exercises

1) What is a wireless messaging service? Name three main services of this type, and explain their role in m-business and/or m-government through real-life examples.

2) What is a mobile portal and what are its main characteristics? Explain through a real-life example.

3) What is mobile commerce and and what are its main variants? Explain through real-life examples.

4) What are mobile customer relationship management systems (M-CRMs) and what are the business motivators for M-CRM? Explain through real-life examples.

5) What are mobile supply chain management systems (M-SCMs) and what role do they play in m-business? Explain through real-life examples.

6) What is LBS and why is it important for m-government and m-business? Give examples of each.

7) What is a wireless sensor network and what are its main applications? How are sensors related to RFID, if at all?

8) What are mobile agents and what possible role can they play in m-business and m-government? Give some real-life examples of mobile agents.

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Some Links:

- Mobile Info Website (http://www.mobileinfo.com/).
- www.redherring.com/discussions/ – a good site for *Red Herring* magazine. Search for articles on "mobility" or "mobile."
- Mobile Commerce Trends site (maffin.net/mobile-commerce/sample.htm) – you may have to sign up.
- www.mbusinessdaily.com – *M-Business Magazine* website. A good site for industry developments and news.
- http://www.wirelessweek.com/ – website for wireless news.
- www.gmcforum.com/ – website for global commerce.com.
- www.mobile-commerceworld.com/mobilecomuk2000/ – mobile commerce world site.
- www.openmobilityalliance.com – website for Open Mobility Alliance.
- www.ericsson.com
- www.nokia.com